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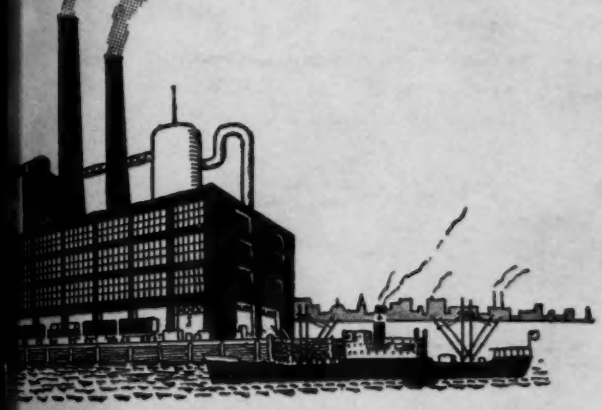

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ECONOMIC GEOGRAPHY

VOL. 28 JANUARY, 1952 No. 1

EVOLUTION OF THE BANANA INDUSTRY OF COSTA RICA

Clarence F. Jones and Paul C. Morrison

Professor Jones, chairman of the Department of Geography, Northwestern University, is widely known for his work on Latin America. Professor Morrison of Michigan State College, a frequent contributor to this magazine, recently served as consultant to the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica.

IN the United States the retail price of bananas is twice what it was 30 years ago. The consumer is prone to blame this higher price on the control of the banana industry by a few large companies, on the effects of World War II on the industry, or on the high cost of labor in shipping and marketing the product. True, the production and ocean shipment of bananas are largely controlled by big companies, but this control does not in itself mean high prices. If it were not for these companies, we would have few bananas at any price. The lack of ocean shipping was the chief cause of the precipitous drop in the banana trade during World War II. It took time and money to replace the refrigerated banana ships lost during the war and to rehabilitate neglected plantations, while laborers nearly everywhere now receive much higher wages than they did three decades ago, but these are only a few of the reasons for the higher price consumers must pay. The development of new plantations in more remote areas where irrigation is required for at least part of the year, and the necessity of providing facilities and labor for combating banana diseases have in particular increased costs. The evolution of the banana industry in Costa Rica illustrates these facts especially well.

BEGINNING OF THE INDUSTRY IN COSTA RICA

As is so often the case with a new industry, the commercial banana industry in Costa Rica began as a side line of another activity. It was developed to supply a freight income for the railroad being built by Minor C. Keith from Puerto Limón across the low, swampy, hot, rainy, heavily forested, insect infested and disease ridden lowland, up the deep rugged Reventazón Valley, over the continental divide at 5137 feet, and down across the Meseta Central to San José.

In 1871, Keith at the age of 23 went to Costa Rica to join his three older brothers, who had a contract with the Costa Rican government to build this railway. The construction of the first 25 miles out of Limón was costly in money, material, and men; it cost 4000 lives, including those of Keith's three brothers. Construction was interrupted many times because of disease, heavy rains, lack of laborers, and lack of finances—once construction was sus-

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pended for nearly three years while Keith raised more money. Not until 1882 was the railway completed to Río Sucio, about 70 miles from Limón. Nineteen years were required to complete it over a distance of 103 miles.[1]

Realizing the urgent need for freight income as construction across the lowlands proceeded slowly, Keith decided to go into the commercial banana business. He obtained a supply of rootstalks (rhizomes) from the Aspinwall area (now the Colón area of the Canal Zone) for experimental plantings. Keith had good reasons to believe that he could develop a commercial banana industry in Costa Rica because following 1866 the Frank brothers had made many regular shipments of bananas from Aspinwall to New York on Pacific Mail and other steamships. In the early 1880's, during the French attempt to construct the Panama Canal, the shipment of bananas from Aspinwall practically ceased, however, as high wages attracted planters to the canal project.[2]

As construction of the railway proceeded, Keith planted bananas in the Zent and Matina Valley areas tributary to the line. In the meantime he experimented with banana shipments. In 1872 he made an initial shipment of 250 bunches from Aspinwall to New Orleans on the deck of *SS Juan A. Meiggs*, the first steamer shipment of bananas to New Orleans. This was followed by regular shipments on this boat. When the Costa Rican plantings began to bear, the first shipments from Limón were made to New Orleans in 1878. In 1879 and subsequent years Keith made ship-

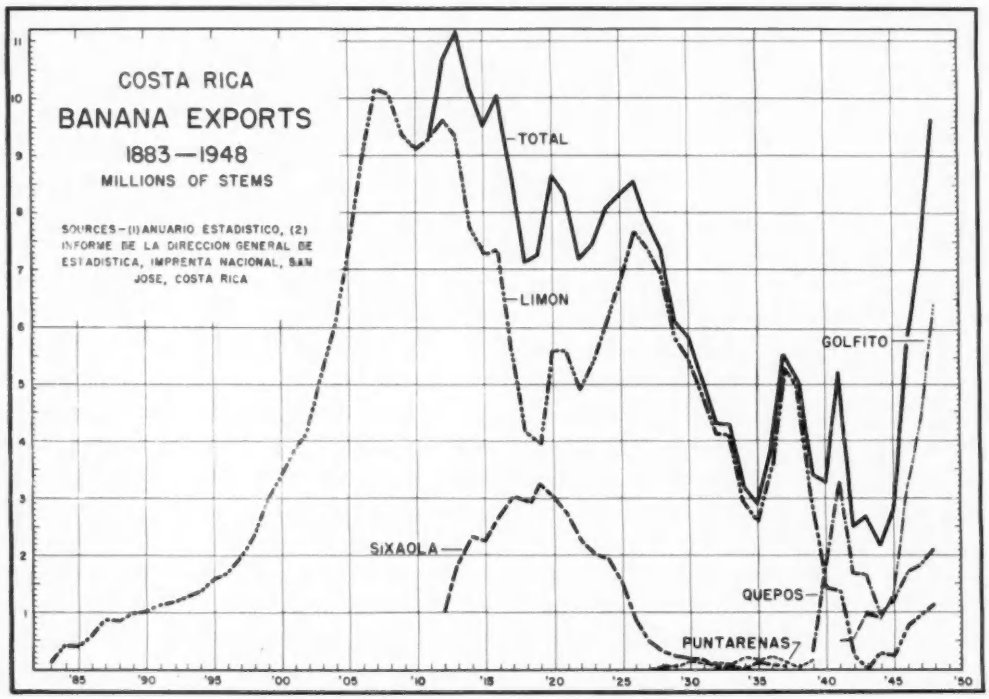

FIG. 1. Banana exports of Costa Rica by ports of origin. The export value at Limón in 1890 was 37 cents per stem. Not until 1904 did it reach 50 cents. In recent years it has been 80 to 85 cents.

[1] Philip Keep Reynolds: "The Banana," Boston, Houghton Mifflin Company, 1927, pp. 40–42.

[2] *Ibid.*, p. 40.

ments from Limón to New York in joint account with Atlas Line steamers and to New Orleans in joint account with J. L. Phipps Company. In March 1899 the United Fruit Company was formed through the consolidation of the Boston Fruit Company, obtaining fruit from the West Indies, and the companies headed by Minor C. Keith, which secured their bananas from Central America and Santa Marta, Colombia.[3]

In 1883 exports from Costa Rica, all through Limón, totalled 110,000 bunches, valued at $47,000. With large new plantings coming into bearing, the exports from Limón reached 1,035,000 bunches in 1890, valued at $410,000.[4] The experimental work of the first 20 years set the stage for the tremendous growth of commercial banana production not only in Costa Rica, but also in other areas of Caribbean America, and paved the way for the great consumption in the United States, Canada, and United Kingdom. Prior to 1902, however, except for the year 1895, all shipments of bananas from Costa Rica were to the United States.

RAPID GROWTH OF THE INDUSTRY IN THE CARIBBEAN LOWLANDS OF COSTA RICA

Exports from Limón rose from 1,035,000 bunches in 1890 to 3,420,000 stems in 1900 and to 10,166,550 bunches in 1907. Up to this time only the area tributary to Limón contributed bananas for export (Fig. 1). However, about 1906 the United Fruit Company, having brought the plantation area in Bocas del Toro, Panama, into production as far west as the national boundary, crossed the Río Sixaola and began developmental work in that district of Costa Rica (Fig. 2). The bananas from this area moved by rail across the Costa Rican-Panamanian boundary and were exported via Almirante, Panama. In 1912 the Sixaola district exported 1,020,000 bunches. The all-time peak in the exports from Costa Rica was reached in 1913, totalling 11,170,800 bunches, of which the area tributary to Limón supplied 9,319,100 and the Sixaola district 1,851,700 stems.

During this period of great expansion the Caribbean Lowlands of Costa Rica were considered by the Fruit Company and by independent growers as just about ideal for large-scale commercial plantation banana culture. The coastal, alluvial, and gently sloping piedmont plains of these areas were near the seaports, so that bananas could be moved by cart or mule from company plantations and independent farms to railways and thence to the ship-side within 24 hours or so. Rapid movement of cut bananas from field to steamship hold is desirable in order to prevent ripening from setting in.

The physical conditions of these areas in many respects are favorable to banana production. In one year the plant grows to full size—about 25 feet high and 14 inches in diameter at the base—and bears a bunch of fruit which, when mature, weighs from 50 to 80 pounds (Fig. 4). For such a rapid growth the plant needs heat, moisture, adequate drainage, and fairly fertile soil. The annual precipitation at Limón is 121 inches. In districts nearer the foothills of the mountains the precipitation is greater. No month receives less than five inches; six months get more than ten inches each. At Limón the mean monthly temperatures range between 77° F. and 81° F. The numerous streams crossing the plains provide outlets for

[3] *Ibid.*, pp. 42, 43, and 51.

[4] All export statistics compiled from volumes of: *Anuario Estadístico*, San José, Costa Rica, Imprenta Nacional; and *Informe de la Dirección General de Estadística*, San José, Costa Rica, Imprenta Nacional.

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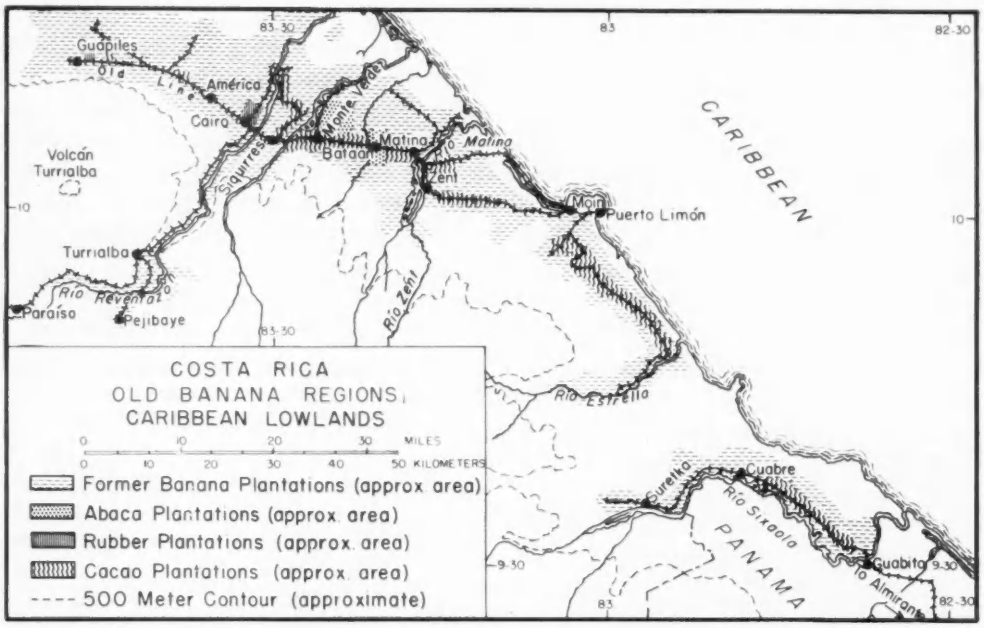

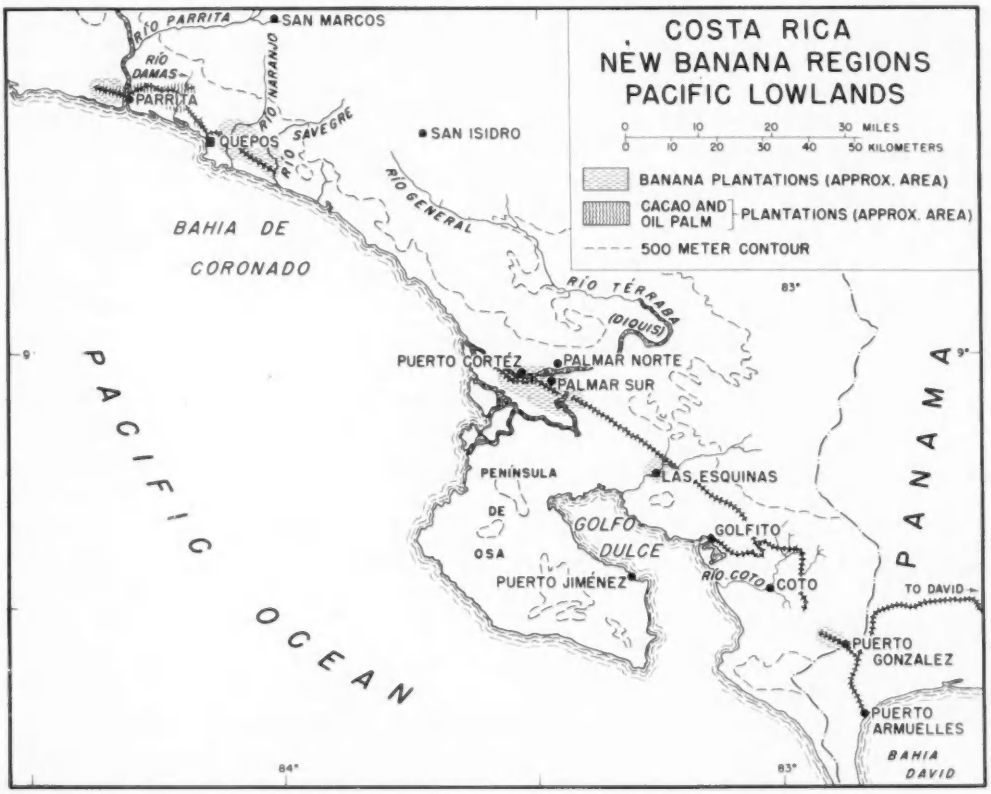

FIG. 2. Old banana regions of Caribbean Lowlands of Costa Rica. Although the United Fruit Company has withdrawn from all fruit activities in the Caribbean Lowlands, it still operates 23,500 acres of cacao and 10,063 acres of abacá here. Also, on or near the old banana plantations are about 2500 acres in rubber, 20,000 additional acres in cacao, about 5000 acres in individual banana plantings, and thousands of acres in corn, beans, rice, cassava, other food crops, and pasture.

FIG. 3. Banana districts on the Pacific Lowlands of Costa Rica.

the many drainage ditches constructed across the low-lying land. Sandy clay loam soils, containing not more than 40 per cent clay, used to be considered the best for banana culture and these are common in the eastern lowlands. The soil must be fairly deep to prevent waterlogging around the roots of this water-sensitive plant, the nutritive elements must be fairly high, and the lime content likewise, for acid soils accelerate the spread of disease. The combination of all these conditions over fairly large areas in eastern Costa Rica was basic to the great expansion of commercial banana production.

The Caribbean Lowlands of Costa Rica had their handicaps, however. At times strong winds of 25 miles per hour or more caused extensive blowdowns of fruit. As population was sparse, West Indian Negroes had to be imported to provide the labor force. Malaria and other tropical diseases of man had to be combatted. By experience the United Fruit Company found that heavy precipitation and growing bananas made heavy inroads upon the humus and nitrogen in the soil, and that as the organic material of the soil decreased, the clay and clay loam soils became compacted, thus decreasing soil drainage. Because of this and because the banana plant cannot stand water in the top foot of soil for more than 12 consecutive days, it was found that the less-well drained clay or clay loam soils back from the rivers were short-lived, lasting only from five to eight years, whereas sandy soils on the natural levees were the best and longest-lived. Furthermore, the Panama disease (*Fusarium cubense*) or wilt disease appeared in the older plantings, causing their abandonment. According to McKenny, typical infestations of the Panama disease were observed as early as 1890 and the disease had obtained alarming proportions in Panama and Costa Rica by 1904.[5]

Decline of the Banana Industry of the Caribbean Lowlands of Costa Rica

Following 1913, the peak year of banana shipments from Costa Rica, the exports from the Caribbean Lowlands declined irregularly to a low of only 1,411,000 bunches in 1941. This was true despite the fact that the exports from the Sixaola district increased from 1,851,700 stems in 1913 to 3,312,450 bunches in 1919. The decline has been attributed to several things. Among these are soil exhaustion and increasing distances of rail haul to the ports. However, two banana diseases, Panama disease and Sigatoka, have been advanced as the chief causes for the decline.

In the early years some planted areas lasted for only five to eight years, whereas other plantings lasted for as long as 25 years. Thus, in its operations in the Caribbean Lowlands the United Fruit Company was early forced to adopt a policy of regular abandonment of old fields and planting of new ones. This policy was possible only because of the large area of suitable virgin land available under contract agreement to the company. In general, individual private growers could not adopt this policy because most holdings were too small to permit it.

While soil exhaustion might in time have contributed to a decline of the banana industry in this region, evidence points to the fact that this was not a major factor in the decline which occurred. "Actually, unlike many crops, bananas are not exhaustive of the general fertility of the soil, their demand

[5] R. E. B. McKenny: "The Central American Banana Blight," *Science New Series*, XXXI (1910), pp. 750–1.

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being largely for nitrogen."[6] While it is true that, as banana plantations were developed farther and farther from the ports, the bananas had to be hauled by rail longer distances, this also was a minor factor in the decline. The longest rail haul for bananas to Limón was less than 75 miles. In Guatemala millions of bunches each year are shipped by rail from the Pacific Lowlands to Puerto Barrios on the Caribbean Sea, a distance of more than 350 miles.

There seems to be no question but that the Panama disease was the major cause for plantation abandonment and the decline of banana growing in the Caribbean Lowlands of Costa Rica. It is reported that by 1910 at least 15,000 acres of banana land had been abandoned in Panama, that many thousands more in that country were seriously affected by the Panama disease, and that the damage in Costa Rica was even greater.[7]

Panama disease attacks the plant through the root system, causing the leaves to wilt and the plant to rot off at the ground. An infected plant does not produce a bunch of bananas. Infected soils cannot be used for growing bananas again for years. Despite intensive research and the expenditure of much money, no cheap and effective method of controlling the spread of this disease has been discovered. However, "United States' scientists are reported to have found a way of stopping the Panama disease. The 'cure' involves addition of hydrated lime, phosphate and potash to the diseased soil and planting to legumes such as crotelaria or velvet beans, plowing under several

FIG. 4. Plantation scene in area tributary to Limón, 1931. On a "mule farm" a three man crew, consisting of a cutter, a packer, and a mule driver, cares for 30 acres of bananas, weeding, pruning, and harvesting them. (Photograph by Clarence F. Jones.)

of these legume crops for a period of one or more years, before replanting to bananas."[8] Also, infested lands in northern Honduras have been reclaimed for banana production by flooding for a year or more and redrainage before replanting. So far as is known, neither of these methods has been tried in eastern Costa Rica where the disease thrives with the heavy, evenly distributed precipitation and the high relative humidity, especially on low-lying acid soils.

The peak year of banana production in the area tributary to Limón was 1907. Subsequently, the exports from Limón fluctuated considerably, increasing as newly-planted lands came into production and decreasing as other diseased plantations were abandoned. By 1926 the United Fruit Company had aban-

[6] Lyall E. Peterson: "Agricultural Development Prospects for Costa Rica," Report of the Inter-American Development Commission (Washington, 1947), p. 70.

[7] C. W. Wardlaw: "Diseases of the Banana and the Manila Hemp Plant," Macmillan & Co., London, 1935, p. 22.

[8] Quoted in: Alice M. Taylor, "Bananas," *Industrial Reference Service*, Part 5, IV, 2 (Feb. 1946), p. 3.

doned 29,500 acres of banana land in eastern Costa Rica.[9]

From 1929 to 1934 the United Fruit Company was planting in the Limón hinterland new land that went out of production in two or three years as a result of Panama disease. Production consequently declined to 2,611,800 stems in 1935. About this time the United Fruit Company decided that it was fighting a losing battle with this disease. Because of the great cost of developing plantations which were short-lived, the company could no longer maintain profitable production of bananas by the plantation method in this area. In 1935 and 1936 the company started a program of encouraging independent growers to plant bananas for sale, of contracting to purchase these bananas at about 50 cents per stem, and of leasing the growers company land. Many such plantings were put in to provide temporary shade on cacao farms, belonging chiefly to the company. The increased exports of 1937 and 1938 resulted primarily from these efforts.

In 1938 Sigatoka (*Cercospora musae*), a leaf spot disease, first appeared in the lowlands of eastern Costa Rica. This disease attacks the leaves and prevents the plant from producing large bunches of high quality bananas. Soon after Sigatoka appeared experiments were made to control it by airplane dusting of the plantation with a mixture of copper sulphate and lime. The dust did not adhere readily to the glossy top side of the young leaves, or was soon washed off by heavy rains, and the system otherwise proved impracticable. The disease is now controlled in other banana areas by spraying plants with Bordeaux mixture.

When the effects of this new disease became important in 1939 and 1940, causing the quality of the bananas to decline, it became less and less profitable for the United Fruit Company to purchase fruit in the Limón area for export. Although the United Fruit Company had abandoned plantation production of fruit in eastern Costa Rica before Sigatoka appeared, this disease hastened the withdrawal of the company from all fruit activities in the area. Exports from the Sixaola district, owing largely to the ravages of the Panama disease, had practically ceased by 1938. So far as the purchase and export of bananas is concerned, the United Fruit Company pulled out entirely from the Caribbean Lowlands of Costa Rica in 1942. The last ship in 1942 was sunk at the Limón dock by a torpedo from a German submarine, and no ships called in 1943.

The United Fruit Company has had no part in the renewal of shipments from Limón since 1943. The exports from Limón in 1948 were 1,130,670 stems. Independent buyers are operating in the area, paying fairly high prices. This results in many small plantings by Negro and white farmers. These consist chiefly of scattered groups of plants, varying from as low as 25 to 50 plants to as much as four acres. No large plantings are present. The plantings are usually mixed with cacao, cassava, or other crops. Panama disease kills out the plantings in two or three years. Sigatoka, although it may not seriously affect the plant the first two years, does reduce the quality of the fruit. No spraying to control Sigatoka is done. It would be impracticable to spray such scattered banana plants, especially in an area where it rains nearly 200 days in the year and where there is no distinct dry season. As a consequence, most of the fruit stems produced weigh only 25 to 30 pounds, which is much below the standards maintained by the United Fruit Company. Some of the bananas now shipped from Limón originate in

[9] Wardlaw, *op. cit.*, p. 22.

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the San Carlos and Sarapiguí valleys and reach Limón by launch. If buyers continue to pay 45 cents or more per stem, shipments will continue and there will be a constant shift in land used for production. With 50 years of experience of plantation production of bananas in the eastern lowlands of Costa Rica as a matter of record, a revival of company plantation banana culture there is unlikely in the foreseeable future, even if effective methods of controlling Panama disease should be developed.

FIG. 5. Cacao in the Limón area, planted on former United Fruit Company land. (Photograph by Clarence F. Jones.)

RISE OF OTHER CROPS

Although the United Fruit Company no longer engages in any aspect of the banana business in the Caribbean Lowlands of Costa Rica, it still has significant interests in the area. The company first began planting cacao here on abandoned banana lands on a large scale in 1914.[10] Today, somewhat more than 40,000 acres are in cacao in Costa Rica, mostly in the eastern lowlands.[11] The company has about 23,500 acres of the cacao in this area.[12] The remainder is in the hands of independent growers who either own or rent the land (Fig. 5). Because prices for cacao were low during the period between the two world wars, the plantations were generally neglected, native vegetation invaded them, and they suffered progressive inroads by a fungus disease, known as pod rot (*Phytophthora*), which attacks the young fruit and rend-

[10] Peterson, *op. cit.*, p. 74.

[11] Helen B. Whitmore: "World Cacao-Bean Production and Trade," Foreign Agriculture Report No. 29, Office of Foreign Agricultural Relations (Washington, 1948), p. 18.

[12] Samuel Zemurray: "Fiftieth Annual Report to the Stockholders of the United Fruit Company for the Year 1949," Boston, 1950, p. 18.

FIG. 6 (left). Tramcar loads of abacá stalks being shipped to plant; abacá in background. (Photograph by Paul C. Morrison.)

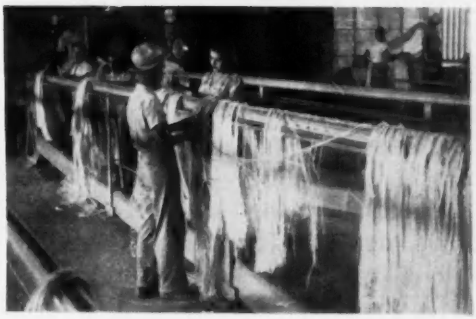

FIG. 7 (right). Straightening and sorting abacá fibers that have come from the decorticating machine, as they move to the drying kiln in upper left at Bataan. (Photograph by Paul C. Morrison.)

ers it valueless. Nevertheless, cacao harvesting continued, and during the recent period of high prices these older plantings were largely reclaimed and given better care.

Experimentation over many years has led during the past ten years to the development by the United Fruit Company of high-yielding, disease-resistant trees.[13] Plantings of these have to date been almost entirely in the Pacific Lowlands, however.

In the 1930's the United Fruit Company began experiments in the old banana area with abacá. During World War II, it planted abacá and developed the necessary decorticating plants for the production of Manila hemp under a war contract with the United States Government on a non-profit basis (Figs. 6 and 7). In 1950 the company reported that at the end of 1949 it had 10,063 acres in abacá.[14] This acreage is in two plantations, known as Bataan (Good Hope) and Monte Verde. An additional independent planting of about 125 acres is located along the railway west of América. As the war contract expired December 31, 1948, the United Fruit Company now operates the above two properties for the Reconstruction Finance Corporation on a management fee basis. No serious disease damage has occurred in the abacá plantations as yet, although recently a disease whose character is not completely known has appeared and is causing trouble. Abacá fiber production in 1948 amounted to 14,065,000 pounds, of which 13,870,000 pounds came from United Fruit Company plantations.

In 1936 the Goodyear Rubber Company started work on a 1000 acre rubber plantation at Cairo in the Caribbean Lowlands. The South American Leaf Blight soon attacked the trees and the immediate program consisted of attempts to combat this disease. However, by 1941 a resistant variety had been located.[15] The company now has more than 2000 acres on former banana lands in two plantations at Cairo and Linea Vieja. They are doing well (Fig. 8). Several small farm plantings, totaling about 20 acres, are scattered over the area. Also, there are 150 acres on an experimental farm near Guapiles. All these areas are planted with disease-resistant, high-yielding varieties which will yield, when the trees are in full production, an estimate of nearly 1000

[13] Vance Rogers: "Abacá, Cacao, and the African Oil Palm in Costa Rica," Institute of Inter-American Affairs (Washington, 1947), p. 13.

[14] Zemurray, *op. cit.*, p. 18.

[15] Peterson, *op. cit.*, pp. 88–96.

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pounds to the acre, compared to an average of 400 pounds per acre in the Far East.[16]

On and adjacent to abandoned banana plantations is other significant agricultural production. "In the Old Line area is the most important corn-producing area of the country."[17] This and other sections, such as the Estrella and Sixaola valleys, also grow beans, rice, cassava, sweet potatoes, other food crops, and pasture.

The precipitation, temperatures, soils, and drainage in this area are favorable to the production of cacao, abacá, and rubber. In time much of the land formerly in bananas in the Caribbean Lowlands of Costa Rica may be growing these and other plantation crops on a profitable basis. The high cost of labor in the area in comparison to that in other regions growing these crops is considered the chief handicap.

Shift of the Banana Industry to the Pacific Lowlands of Costa Rica

For many years bananas have been produced in the Pacific Lowlands of Costa Rica. The first shipments from a Pacific Coast port were in 1927. For several years independent operators purchased bananas, grown in the coastal valleys, and moved them in launches and small boats north to Puntarenas for shipment to foreign markets. In 1935 the United Fruit Company began buying bananas from independent producers and transporting them by tug and barge to Puntarenas for export. The 57,000 to 235,000 stems exported through Puntarenas annually between 1928 and 1939 thus came by coastwise pickup chiefly from the Río Parrita and Río Naranjo areas. These shipments fluctuated considerably, declining as the Panama disease made serious inroads on individual plantings and increasing as new ones came into bearing.

By 1938 the United Fruit Company had decided to shift its banana operations from the Caribbean Lowlands to the Pacific Lowlands and signed a contract with the Costa Rican Government for this purpose. Development work began at once. The new dock at Quepos was opened late in 1939, causing shipments from Puntarenas to cease. As Sigatoka began lowering the quality of bananas from the individual owners' plantings, the United Fruit Company quit buying from infected holdings. In the Pacific Lowlands the company organized two banana divisions, the Quepos and the Golfito divisions (Fig. 3).

The Quepos Division

As noted above, banana culture by independent growers had been developed

FIG. 8. Showing girth of eight-year-old seedling Hevea rubber tree. (Courtesy of the Inter-American Institute of Agricultural Sciences.)

[16] "News by Commodities," *Foreign Commerce Weekly*, XXXII (August 21, 1948), pp. 34–5.

[17] Jorge León: "Land Utilization in Costa Rica," *The Geographical Review*, XXXVIII (1948), pp. 444–56; reference on p. 454.

in the Río Parrita and Río Naranjo valleys in what is now the Quepos division before the United Fruit Company became active in that area. In the Parrita area the company purchased some 1500 independently established acres and contracted to spray and purchase the fruit from another 600 acres. It also continued to purchase fruit from 2000 acres of independently established plantations in production in the Naranjo Valley until late in 1946, but these acres, abandoned because of Panama disease, are now in a cattle farm. The Quepos division consists of four districts: the Naranjo; the Savegre; the Savegre East in the coastal valleys to the south of the Naranjo; and the Damas to the north.

In 1941, owing to the rapid plantings by the United Fruit Company in the preceding two years, the Quepos division produced and exported 3,296,000 bunches of bananas. The shipments dropped off rapidly during the war years because of the lack of ships and abandonment due to Panama disease. Until 1946 shipping was scarce. In 1948 exports totalled 2,128,100 bunches (Fig. 1).

Banana production and exportation from the Quepos division will probably reach a peak in 1951 and then they will rapidly decline and eventually disappear. Large acreages were planted in 1948. The year 1949 was the last year of large plantings. Most of the land in this division is short-lived, commonly yielding for only about five years before it has to be abandoned.

The life of a banana planting depends chiefly upon the acidity of the soil and upon drainage conditions, because of their relation to the spread of the Panama disease. An acid soil develops Panama disease more quickly than other types. The number of years a planting will produce depends chiefly on the soil's pH, calcium-magnesium ratio. Soils with a high pH, a high calcium-magnesium ratio, are most resistant to the development of the Panama disease. Heavy clay soils, other things being equal, are more resistant at the same calcium-magnesium ratio. However, as pointed out above, heavy clay soils, after the removal of organic material in the top soil, are likely to become compacted and thus present special problems of drainage. Panama disease will spread more rapidly in a less well-drained soil than in one that is properly aerated. However, the shortest-lived soil would be an inadequately drained sandy soil with a low pH, a low calcium-magnesium ratio. A light clay to clay loam soil ordinarily gives the heaviest production.

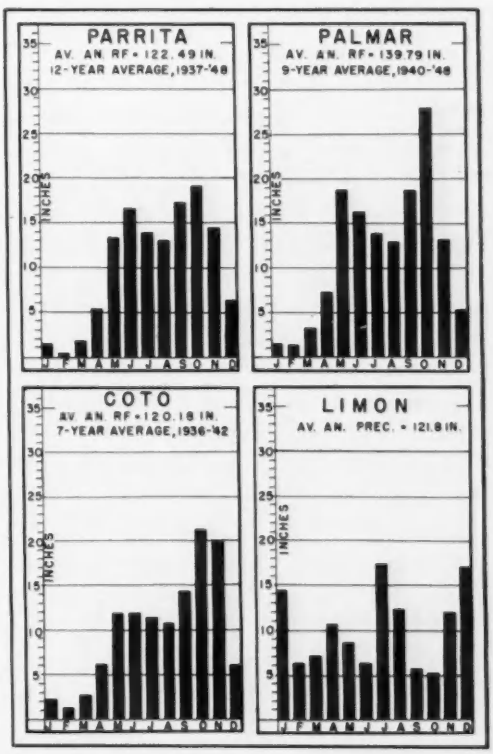

FIG. 9. Precipitation at four stations, one in the Caribbean Lowlands and three in the Pacific Lowlands. In most of the banana districts of the Pacific Lowlands the annual precipitation, despite a dry season of three months, is heavier than it is at Limón on the Caribbean coast. (Figures compiled from United Fruit Company records of the Quepos and Golfito divisions.)

It is the present policy of the United Fruit Company not to plant any soil with a life expectancy of less than five years. As pointed out above, the best soils will produce for as long as 25 years. In the Quepos division land suitable for banana culture has been largely developed. Land contiguous to the plantations either has a life expectancy of less than five years, is too hilly for use, or lies along the coast in a narrow one-mile wide strip which is national land that by law cannot be sold or leased except for the construction of a port.

As land in the Quepos division is abandoned for banana growing, the United Fruit Company follows a policy of planting other things, such as cacao, African oil palm, pasture, and small areas of mahogany and teak. At the end of 1948 the company had in the division 2500 acres in cacao, mostly consisting of high-yielding, disease-resistant strains. The annual precipitation of 100 inches or more, the long rainy season from April to November, and the subsequent dry season all should favor the growth, ripening, harvesting, and preparation of high quality cacao beans (Fig. 9). In this area there are also approximately 8000 acres in African oil palms, some of which began to bear in 1949. The soils and the rainfall regime in this area are apparently well-suited to the growth of this palm. Judged from experimental plantings over several years, no serious disease or insect pest problems are anticipated.[18] The Damas district, referred to above, is now all in oil palm and cacao. Tentative plans of the United Fruit Company call for eventually planting in the Quepos division some 16,000 acres of cacao and 10,000 acres of oil palm as banana fields are abandoned. Of course, very low prices or the lack of markets for these products could alter these plans materially.

The United Fruit Company is now consciously following the policy of putting something productive on banana lands as they are abandoned, so as to prevent or lessen distress such as has occurred in the past in some areas of abandonment. The company considers this "good business." It is certainly enlightened policy insofar as utilization of resources and the expanding of economy in tropical areas are concerned. Even though there may be some decline in the economy of a banana area, once the bananas go out, there is left a greater development and more people in such areas than would have been there if banana plantations had never been developed. The banana plantations thus serve as an important agency for expanding settlement and converting unoccupied tropical lands to a more effective use.

THE GOLFITO DIVISION

Before the United Fruit Company began development work in late 1938, much of the area of the present Golfito division was either uninhabited or very sparsely settled tropical rain forest. However, there was a small production of bananas at Palmar on the Webb farm before the company came. Also, there were a few people along the Térraba River, as at Puerto Cortéz, and several small settlements along the coast.

In a decade the United Fruit Company brought the activities of the division up to high level. It built 246 kilometers of railway lines; constructed modern banana shipping facilities at Golfito, with equipment for loading 4000 bunches of bananas an hour; built a town of some 7000 people, with a modern hospital, stores, construction shops, communication, recreation, and other modern facilities; developed near Golfito a dairy

[18] Peterson, *op. cit.*, p. 78; Julio O. Morales, Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, in a letter of March 20, 1950.

farm with 50 head of cows and a modern pasteurizer; and brought into production thousands of acres of bananas. The main line railway from Palmar and the port at Golfito were completed in 1941, the port being finished before the railway. It also brought into the area, in addition to company officials, some 15,000 white and mestizo persons as workers from Guanacaste and other west coast localities. In addition to workers living on the plantations or in Golfito, the company has encouraged settlers to establish themselves along the main line railroad between banana districts. These people provide the extra labor needed at the wharf during banana loading operations, the extra workers required in development and new construction, and at times labor for other rush activities. Between periods of work of this character these settlers grow on small plots much of their own food and also food for the population of Golfito.

Banana exports from the division increased rapidly. Before the company entered the area the Webb farm had shipped some bananas coastwise by barge to Puntarenas for export. Also, a little fruit produced in 1940 on company holdings in the division and that produced in the early part of 1941 moved via barge to Quepos for export, but in the latter part of 1941 exports through Golfito totalled 510,260 stems. Shipments increased to 1,018,350 bunches in 1943, though the war interfered seriously with exports. No bananas were shipped between January and August 1942, owing to lack of ships. The shortage of ships accounted for restricted exports during the remainder of the war years. During this time the plantations were sprayed and otherwise maintained, but the fruit ripened and fell to the ground because it could not be marketed. Shipping was scarce until in 1946. The exports from Golfito in 1948 totalled 6,384,155 bunches.

The Golfito division at the end of 1948 had nearly 25,000 acres in bananas in four districts. Three of the four districts are in the neighborhood of Palmar. The three districts lie on the south side of Río Térraba (or Río Diquis, as it is called in its upper course) and have nearly 16,000 acres of bananas in farms of 800 acres each. In addition, there are 2000 acres of independently-owned bananas (known as the Webb farm) on the north side of the river. These are sprayed and the fruit is purchased by the United Fruit Company. Bananas from this farm are carried across the river by cable line to the railroad. Farther down the river on the north side are also 400 acres of independent plantations and on the south side of the river some 1200 acres of independent plantations from which the company purchases the fruit. Fruit is purchased at about 25 cents per stem under a long-term contract, the United Fruit Company covering the cost of spraying, fertilizing, and irrigating, and carrying out these operations. Half way between Palmar and Golfito is the fourth banana district, the Esquinas district, with some 5000 acres of company plantations.

In extreme southern Costa Rica in the southern part of the Coto region the company has another banana area. Part of this is in Costa Rica and part in Panama. When the farms were laid out they were thought to be in Panama, but a settlement of a boundary dispute between the two republics placed the boundary through the plantation area. Production in the Costa Rican portion started about 1945 with some 300,000 stems. In subsequent years plantings were large so that the production in 1949 probably amounted to more than one million stems. These bananas cross the

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border into Panama at a point called Puerto Gonzalez on their way to Puerto Armuelles. Bananas that cross the border and are shipped to Puerto Armuelles are included in the Golfito totals because no separate figures are available for these shipments.

Each of the districts in the Golfito division is divided into a number of farms, the number varying from five to nine; seven is the ideal and the most usual number. The typical farm, rectangular in shape, consists of 800 acres of bananas, with about 20 acres devoted to campsite and buildings, and may have as many as 150 acres in pasture land (Fig. 10). Each 800-acre farm requires the labor of 150 workers employed the year round. Included are about 81 workers who weed, prune, and harvest the bananas, 40 spray men, 8 fruit washers, 8 stevedors, 5 irrigation men (during the season of irrigation), 3 foremen, 2 timekeepers, 1 overseer, 1 stockman, and 1 sanitation man. Once a plantation is established, 54 per cent of the labor on a farm is engaged full-time in weeding, pruning, and harvesting. Weeds and other undergrowth are chopped out every two months; alternating with cleaning, pruning is done every two months; each farm is gone over twice weekly to harvest the fruit. A farm is called a "tractor farm" or a "mule farm," depending on the method of bringing the bananas from the fields to rail sidings (Figs. 4 and 13). Diesel tractors pull trailers for hauling bananas. Each small mule, two mules to one driver, packs out two bunches at a time. Oxen are not used. However, each farm

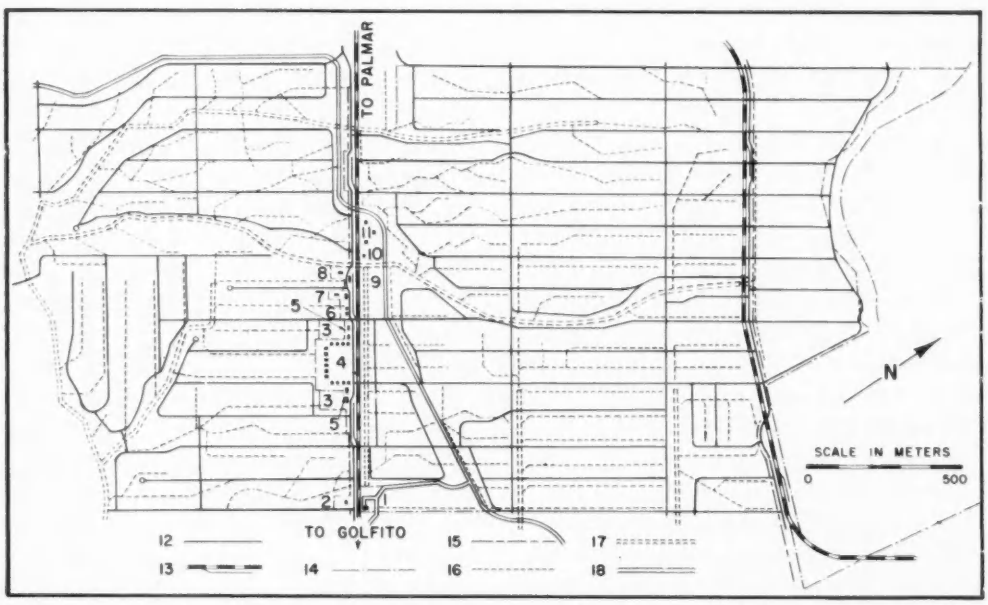

FIG. 10. The plan of a typical banana farm in the Golfito division. 1, irrigation pump building; 2, irrigation pump operator's house; 3, fields of plantain for workers' food; 4, two-family houses for married workers; 5, barracks for single workers; 6, houses for foremen; 7, houses for spray laborers; 8, shed for tractors and trailers; 9, Sigatoka spray mixing and pumping building; 10, stable for riding animals (mules); 11, houses for timekeeper, overseer, and assistant overseer; 12, roads; 13, railroad and railroad spurs; 14, farm boundary not formed by canals or roads; 15, boundary of banana cultivation; 16, drainage ditch; 17, drainage canal; 18, irrigation canal. This farm has an area of 848.3 acres. Of these, 782.5 acres are in bananas, 18.7 acres are occupied by buildings, 25 acres are in waterways, 7.2 acres are in right of way (railroad, etc.), and 14.9 acres are unsuitable for banana cultivation. All bananas are sprayed to control Sigatoka. (Drawn from information supplied by the United Fruit Company.)

may have some cows, and generally has several riding mules and horses.

Some of the operations of developing banana lands and the production of bananas in the Golfito division are not unlike those on the former plantations in the Caribbean Lowlands. On the other hand, some operations, owing to the necessity of irrigation and of spraying for control of Sigatoka, differ greatly.

In the Golfito division the low-lying lands have to be cleared of the forest, drainage ditches constructed, transportation facilities provided, and the bananas planted as these things were done in the former plantations of the Caribbean Lowlands. Master drainage canals are spaced at about 500 yard intervals and secondary drainage ways about every 75 meters. Most of the drainage canals are laid out on a contour drainage system, but in some new farms on flat land a grid system with straight-line drainage ways is used. A straight-line grid system facilitates spraying and harvesting operations. As pointed out above, adequate drainage of land for growing bananas is necessary because the plant cannot stand water in the top foot of soil for more than twelve consecutive days.

Owing to three or more months of light rainfall in the Pacific Lowland banana districts, irrigation is necessary during the dry season in contrast to the former plantations in the Caribbean Lowlands. Drainage canals and irrigation intake canals are separate. Water flows into the intake canals from rivers or estuaries. It is pumped from the intake canals through a system of pipes decreasing from fourteen to four inches in diameter. The irrigation system runs 24 hours a day in season and requires five men to irrigate each 1000 acres. The standard pump handles 5000 gallons of water a minute and works ten towers at a time. Each tower, or riser, puts out 500 gallons of water a minute and irrigates three and one-third acres (Fig. 11). The towers are laid out in systems and are spaced on a hexagonal pattern. Each system consists of 36 risers. There are ten systems on each pump. At any given time only one riser in each system is supplied water from the pump, or ten risers at once. If each of the 36 risers in a system is worked four hours, it takes six days to irrigate the land covered by the risers. This pipe system is so constructed that a water pressure of ninety pounds is maintained at the base of each riser. The nozzle on each riser slowly revolves, taking about 30 minutes to make a complete turn. Water is thrown out from the riser nozzle with a 205-foot radius of spray. A minimum of one and one-half inches of water is applied to the area covered in four to five hours time. Each banana field is supplied with this amount of water once a week during the irrigation season. Irrigation on any particular piece of ground is synchronized with spraying, cutting, and weeding, and with irrigation on surrounding areas, so that one activity does not interfere with another.

It has been said that growing bananas with irrigation on the Pacific Lowlands offers many advantages over production with natural precipitation on the Caribbean Lowlands: water can be applied in the correct amounts as the plants need it, weed control is easier and soil leaching is less, laborers can work more consistently, and building roads and railroads is easier on lands with low rainfall. It is true that during the dry season of three or four months field work is not interrupted and that construction can proceed more easily. On the other hand, the annual precipitation at stations in the Golfito division is about as heavy as it is in the Caribbean Lowlands of Costa Rica, and at least six inches of

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water per month are sprayed on the fields during the dry season. The water sprayed on the fields is apparently equivalent to that much precipitation in causing weeds to grow and in leaching the soil. According to soil scientists, the abandonment of soils due to Panama disease seems to be more closely related to drainage conditions and acidity than to leaching alone or to the presence or absence of a dry season. In addition, the provision of irrigation facilities is seriously infected. In both the Quepos and Golfito divisions, however, the banana fields must be sprayed every two or three weeks to control Sigatoka. High-pressure pumps force spray from central mixing houses through two-inch main pipes, one and one-quarter inch laterals, and three-quarter inch sub-laterals. Laterals laid out on a straight grid system are 500 meters apart. Sub-laterals are spaced 60 meters apart with angle valves every 30 meters to which

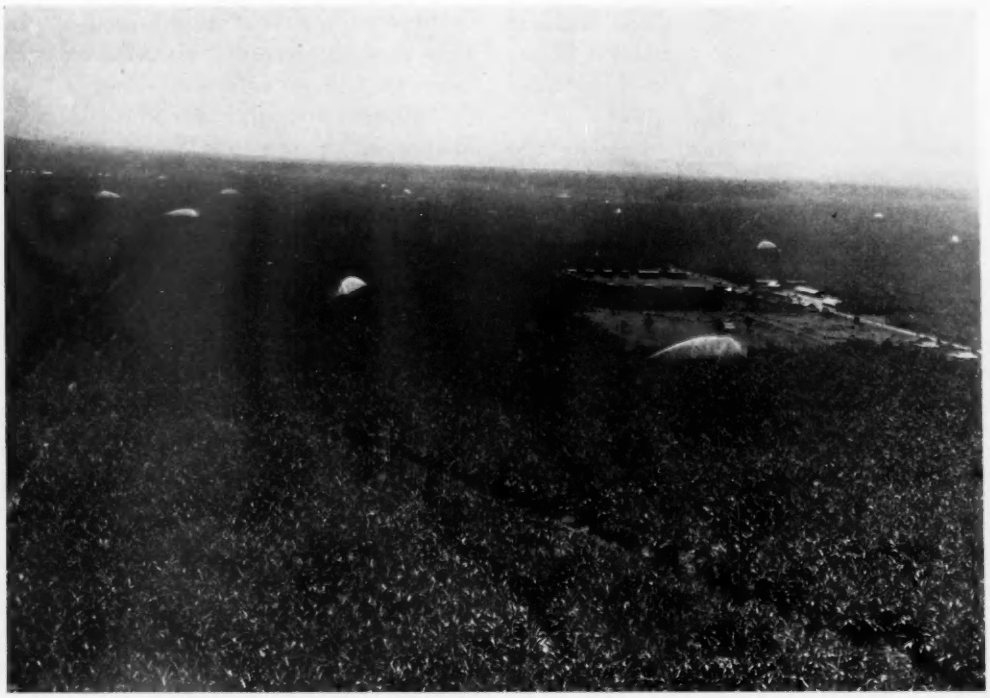

FIG. 11. United Fruit Company farm with overhead irrigation towers in operation; in the right center are administration buildings, laborers' houses, and pasture land. (Courtesy of the United Fruit Company.)

expensive, and five men on each farm are needed to run the irrigation equipment. Furthermore, although until now blow-downs have not been great, the chief danger from wind is in May and June at the beginning of the rainy season.

Up to the end of 1948 Panama disease had appeared in only a few areas in the Golfito division, and these were not

can be hooked a 140 foot hose handled by two men (Fig. 12). The spray mixture used consists of a 5/5/50 ratio, or five pounds of copper sulphate and five pounds of lime to 50 gallons of water. In 1948, about 1250 men worked continuously on Sigatoka control in the Golfito division, one man for every 5110 bunches produced. The company uses each year in this area as much as a

million pounds of copper sulphate and a million pounds of lime.

Controlling Sigatoka is expensive, but without it good banana land would not for long produce large bunches of high-quality fruit. The total cost of pipes, pumps, and other spraying equipment is said to be about as much per acre as the initial expense of preparing and planting an acre to bananas. In addition, 30 per cent of the laborers on each farm are engaged full time in spraying the fields and in washing the fruit. Before the bananas are loaded in cars at rail sidings, the bunches are dipped into a tank containing a dilute solution of sodium acid sulphate to remove the Bordeaux mixture and then dipped into a tank of water to remove the sodium sulphate (Fig. 13).

For decades the popular impression has been that bananas serve only to skim the fertility of the soil and that then the areas won by costly development revert to jungle. There has been and there still is ample evidence for this impression through the abandonment of banana plantings after a cycle of production of from five to 25 years. However, will the Golfito division prove to be

FIG. 12 (left). Spraying to control Sigatoka. (Photograph by Paul C. Morrison.)

FIG. 13 (upper right). Loading bananas on a tractor farm; tractor trailer on left, dipping tanks in center, railway car beyond. (Photograph by Paul C. Morrison.)

FIG. 14 (lower right). The growth habit of the banana plant contributes to the life of a planting. The stump in center represents stalk cut down at time its fruit was harvested; stalk on left will produce bunch next, then one on right, then one in rear. This will continue from old root stalk for years, if plant does not become diseased. (Photograph by Paul C. Morrison.)

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the exception for which fruit men have been looking for more than half a century? Bananas are not exhaustive of the general fertility of the soil; their demands are largely for nitrogen. In this area the United Fruit Company regularly applies nitrogen fertilizer, the amount used varying with the character of the soil and the age of the planting. As yet there has been no abandonment due to Panama disease, but few farms have been in bananas for more than ten years. The soils in the Golfito division are classed by United Fruit Company men as long-lived (Fig. 14). The long productivity of these soils may be due to several conditions: better drainage facilities provided by taking advantage of years of experience, fairly high pH, calcium-magnesium ratio, application of nitrogen fertilizer, and the influence of the dry season on the spread of Panama disease. While these soils may have some characteristic inimical to the spread of the Panama disease, the likelihood is that the longer life is due in part at least to more modern methods of soil management.

The above discussion demonstrates that the achievements of the United Fruit Company in the Quepos and Golfito divisions in only a decade, which included the greatest of World Wars, have been remarkable. Banana exports from the Pacific Lowlands of Costa Rica in 1948 totalled more than 8,500,000 bunches. It seems certain that within a few years the annual shipments from the Quepos and Golfito divisions together will surpass the record combined exports from the Limón and Sixaola regions in 1911 of 11,170,810 bunches. The exports from the Golfito division probably will not reach a peak for another ten to fifteen years. In the vicinity of Palmar some four to five thousand acres more can be planted. But the only land between the Palmar area and Golfito that at present seems suitable for bananas lies in the Esquinas district, and most of the suitable land in this area has been planted. However, in the Coto region southeast of Golfito and farther south toward the Panamanian boundary a large area is suitable for banana growing. Certain developments such as installations of roads, drainage ditches, communication facilities, etc., have already occurred in this land. The presence of this potential banana land influenced the establishment of port facilities at Golfito. When finally developed, banana lands in this area will join, or almost so, with the Panamanian and Costa Rican plantations now shipping fruit out through Puerto Armuelles, Panama.

CONCLUSION AND OUTLOOK

The shift of United Fruit Company activities in production, purchase, and exportation of bananas from the Caribbean Lowlands to the Pacific Lowlands of Costa Rica has been complete. The main cause of this shift must be attributed to the increasing rapidity with which the Panama disease spread to new plantings in the Caribbean Lowlands. In 1935 the company abandoned plantation production of bananas in that area. Apparently, Sigatoka had no part in causing the company to cease plantings, for it did not appear in the eastern lowlands of Costa Rica until 1938. However, Sigatoka, owing to its lowering the size of bunches and the quality of the fruit grown by individual planters and sold to the company under contract, caused the company to cease purchase and export of bananas from this area in 1942. That soil exhaustion, that is the loss of the humus and nitrogen in the soil growing bananas, in itself was a major cause for the shift is questionable. It is true that the United Fruit Company followed the policy of abandonment of old plantings, but a con-

siderable area in the eastern lowlands suitable for growing bananas had not been planted, and some soils in these areas would be long-lived were it not for Panama disease. It is difficult to assess separately the effects of the loss of humus and nitrogen in the soil and of Panama disease because they are interrelated. Although some soils are more resistant to Panama disease than others, no soil entirely immune to Panama disease has been discovered in either the Caribbean or Pacific Lowlands. An earlier contention that the spread of Panama disease in an area with a dry season could be retarded greatly has not been demonstrated by experience in the Quepos division, where in a little over a decade about 12,000 acres of both company and individual holdings have been abandoned because of Panama disease. The Quepos division will probably be largely out of production in another 15 years. Unless the application of nitrogen fertilizer now practiced in the Golfito division and unless an effective method of controlling the spread of Panama disease, as is reported to have been discovered by United States scientists, are followed, the banana lands in this region will in time also go out of production. Commercial banana production at present must still be considered a relatively impermanent system of agriculture.

ACKNOWLEDGMENTS

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THE CHINA CLAY INDUSTRY OF SOUTHWEST ENGLAND

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THE china clay industry of southwest England is, in a sense, the aftermath of the metalliferous mining which is now practically extinct. The relationship of the two is intimate. The vapors which charged the fissures of the rocks with minerals of value also acted upon and changed the surrounding granite to make the clay. Many a clay pit of today began life as a tin mine. Even more have inherited the gear, the pumps and engines, of abandoned tin or copper mines, and have taken over labor thrown out of work by the collapse of metal prices and metalliferous mining.

Geology

The pneumatolytic origin of china clay seems now to be generally accepted. Heated vapors, associated with or closely following the intrusion of the metalliferous lodes, brought about several changes in the granitic rocks of southwestern England, of which kaolinization was the most widespread and most important. It consisted in the breakdown of the feldspar crystals, and the formation of amorphous powder, an hydrated aluminum silicate. The process was accompanied by a slight contraction in volume of the kaolinized rock, and clay beds were in the past commonly recognized by a depression, known locally as a "sladd," in the surface of the ground. In this breakdown of feldspar, the quartz, mica, and any other constituents remained unchanged, and the working of china clay consists essentially in the separation of the clay particles from the residue. The clay rock varies considerably in hardness, and consequently in difficulty of working; in the proportion of recoverable clay to quartz-mica waste; and in the color of the clay itself. Within any one bed, the clay occurs in veins which vary from thin stringers to veins of considerable width, separated by masses of hard, tourmalinized granite.

The formation of china clay by atmospheric agencies is a process which undoubtedly occurs. But its removal by soil creep would seem to balance its formation at the surface, and there is no accumulation, except occasionally in valley bottoms. There is no record that this was ever worked as china clay on anything more than a very small scale. On Dartmoor, large quantities of china clay, together probably with much other clay of superficial formation, have been swept by rivers into the Oligocene basin between Newton Abbot and Bovey Tracey. Here it has been laid down, along with beds of lignite, and is worked as ball clay.[1]

China clay deposits are not scattered evenly over the granite masses of southwestern England.[2] Kaolinization is

[1] Special Reports on the Mineral Resources of Great Britain, XXXI, "Ball Clays," Memoir of the Geological Survey, 1929.

[2] A. Allen Howe: "A Handbook to the Collection of Kaolin, China-Clay and China-Stone," Museum of Practical Geology, London, 1914.

closely related to the mineralized belt which extends from southern Dartmoor across the southern half of Bodmin Moor, and embraces the whole of Hensbarrow, the northern half of the Carnmenellis granite, and most of the Land's End massif. But china clay is very much more localized even than the metalliferous deposits. On Dartmoor it is confined practically to the southwestern corner, overlooking Plymouth. Bodmin Moor has comparatively few deposits. Rather more of the Hensbarrow granite area is kaolinized, though clay beds are most irregular in their occurrence, being almost confined to the southern two-thirds of the area, and even there being separated by considerable areas of barren land. The Carnmenellis granite is almost wholly unkaolinized; only one deposit has ever been worked seriously, and there the working was so intimately associated with tin mining that the clay might almost be regarded as a by-product. To the west is the small, granite inlier of Tregonning Hill, where kaolinization has occurred, closely associated with the formation of tin veins. The Land's End area has a number of clay beds, which are, however, of relatively small value. These have been worked above St. Ives and near St. Just.

Individual clay deposits may range in area from dimensions too small to be workable up to several acres. In no case has a clay bed been bottomed, and the deposits may, in practice, be described as inexhaustible. But it must be remembered that the law of diminishing returns applies with considerable force to mining and related industries, as will be considered later.

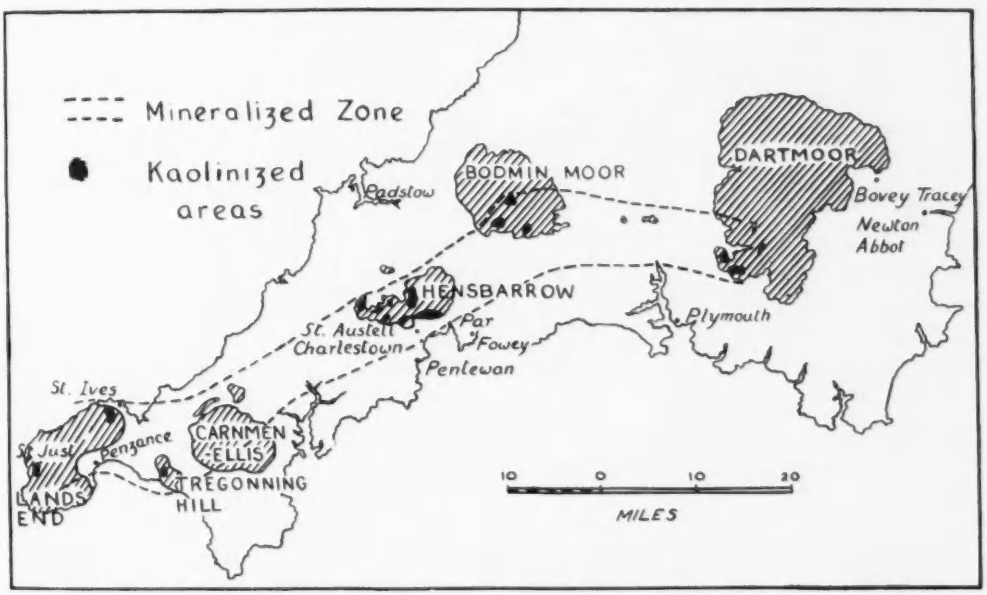

FIG. 1. The granitic areas of Devon and Cornwall. Tin and copper are found associated with the granite only within the mineralized zone, and the china clay deposits are genetically connected with the formation of the mineral lodes.

HISTORY

China clay was discovered in Europe in the eighteenth century as the result of a search continued over a number of years and in several countries, with a degree of care and of attention to geo-

logical detail not generally met with before the later nineteenth century. The search was for the materials of which the true porcelain of China was made. These had been disclosed in rather vague terms in the letters of a Jesuit missionary,[3] and the search began for the hard, vitrifiable constituent, called by the Chinese *petuntse*, and the soft white *kaolin*. The occurrence of the two in close proximity to one another is quite adventitious, except in so far as both are products of granite, the one being a vitrifiable granite free from iron and manganese minerals; the other, a granite in which the feldspar has been decomposed. Réaumur's searches in France met with no great success,[4] but the Saxon, Bottger, lighted accidentally on the deposits of the Erz Gebirge, a discovery from which sprang the Meissen pottery.[5] In France, the deposits of the Limousin were first discovered by Guettard in 1765.[6] Already, however, Cookworthy had come upon the Cornish beds—the year is by no means certain—and had established a short-lived pottery in Plymouth,[7] which was subsequently moved to Bristol.[8] By this time the Cornish clay had engaged the attention of Josiah Wedgwood and of other Staffordshire potters, who, as soon as Cookworthy's patent permitted, acquired the lease of clay beds which they developed for their own potteries.[9] It is impossible here to consider more fully the detail of these events—Cookworthy's actual discovery; the feud between Champion, his successor, and the Wedgwoods; and the influence of the New World, where clay from "the back of Virginia"[10] had begun thus early to cast its shadow over the Cornish industry.[11] Nor is it possible to examine further the production of what came to be known as china stone. Its uses have remained in practice limited to those associated with pottery.

Cookworthy's discovery had been made on the small Tregonning granite mass, already mentioned, but he soon afterwards turned his attention to the larger and richer deposits in the Hensbarrow area, north of St. Austell, and this area has since remained the heart of the industry. It is also the only one which yields china stone in adequate quantities and of sufficient purity for any extensive industrial use. The Tregonning area remained in production, however, until the present century, but has now been abandoned.

The nineteenth century was a period of steadily mounting production. The whiteness and fineness of the clay, its resistance to chemical change, and its relative cheapness opened out a wide range of new uses. It was introduced into the manufacture of the coarser china wares, and, from being an adulterant, it came to be a recognized ingredient of certain foodstuffs and of factory goods as diverse as calico and paper. This prosperity coincided, in the southwest of England, with the closing

[3] "*Lettres édifiantes et curieuses*," edn. of 1781, XVIII, pp. 236–251; also, J. B. du Halde: *Description géographique de l'Empire de la Chine* (1735), II, 188.

[4] "Histoire de l'Academie royale des Sciences," 1727, pp. 185–203.

[5] H. Kopp: "Geschichte de Chemie," Braunschweig, 1843, II, p. 207.

[6] M. Guettard: "Histoire de la Découverte faite en France de Matières semblables à celles dont la Porcelaine de la Chine est composée," Paris, 1765; also, G. Vogt: "La Porcelaine," Paris, 1893.

[7] "Memoir of William Cookworthy," by his grandson, 1854, pp. 47–48, 199–207.

[8] H. Owen: "Two Centuries of Ceramic Art in Bristol," 1873.

[9] E. Meteyard: "The Life of Wedgwood," 1865, I, p. 291; II, p. 311; and Llewellyn Jewitt, "The Wedgwoods: Being a Life of Josiah Wedgwood," 1865, p. 263.

[10] "Memoir of William Cookworthy," p. 22; and J. Prideaux: "Relics of William Cookworthy," 1853, pp. 4–5.

[11] N. J. G. Pounds: "The Discovery of China Clay," *Economic History Review*, *I* (new series), 1948, pp. 20–33.

down of the metalliferous mines. The clay pits inherited the labor corps, the pumping gear, and other appliances and even the industrial organization of the tin and copper mines. The significance of this is twofold. On the one hand, the availability of derelict mine equipment allowed a clay company to establish itself with a smaller capital than would otherwise have been the case. Many, if not most, in these early days were floated by the local tenant farmers, the yeomanry and peasantry, with occasionally the backing of the lesser gentry. On the other hand, labor was abundant, and there was in consequence less inducement to mechanize the pits. This was clearly shown when, in 1911, the clay workers struck successfully for a higher wage. The immediate result was that it became economic to install hoses for washing down the clay from the clay rock in the pits, instead of having it broken down laboriously by the shovels and heavy boots of gangs of clay-workers.

But this nineteenth century organization of the industry left a heavy burden for the twentieth. The companies were very small, and operated with an inadequate capital. They were, often enough, worked by owner-managers. From quite an early date there had been an export of clay, but the innumerable competing companies had insufficient knowledge of foreign markets and were individually too small to maintain their own factors or agents. In the china clay industry of the nineteenth century we see the peasant, conservative and narrow in his outlook, applying himself to industry. The old "clay families" did, however, understand the mineral they worked, and they had staked their claims to

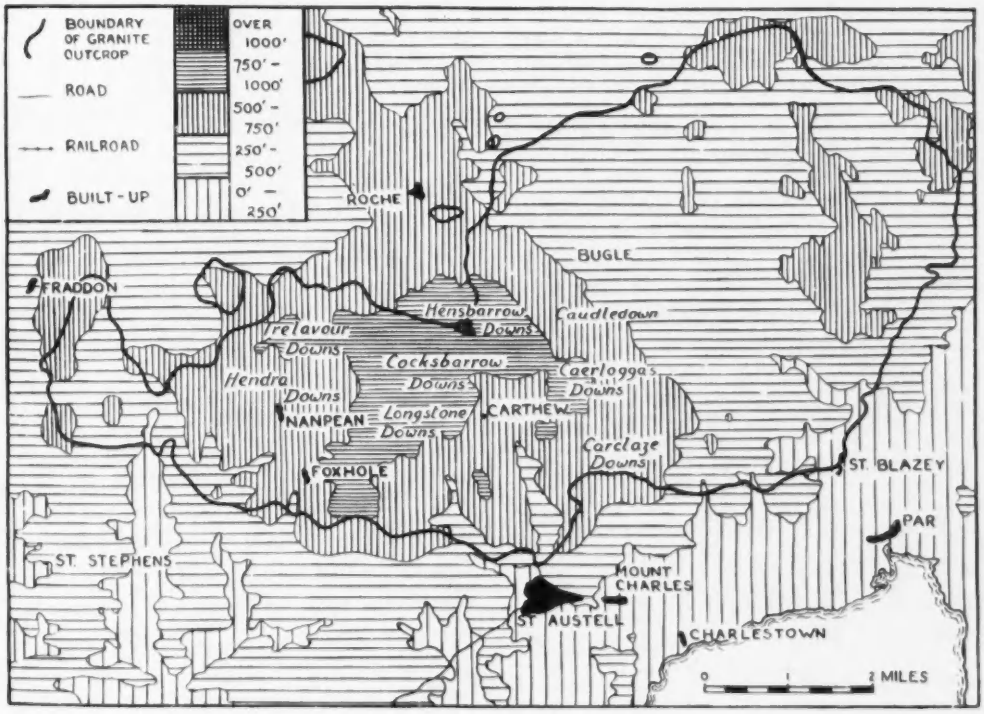

FIG. 2. The Hensbarrow granite area. Relief is much greater than in the non-granitic areas. Most of the kaolinization has taken place in the southern and western parts of the area.

almost every bed of value. Towards the end of the nineteenth century, their success began to attract capital from London. New companies were established and new pits opened by these newcomers to the industry. Their capital and more adequate equipment were not, however, in general matched by clay beds of good quality, and these more highly capitalized concerns were the first victims of the trade depressions, which the older companies, with smaller overheads and a better quality product, were able to survive.

GEOGRAPHICAL DISTRIBUTION

In the volume of *Mineral Statistics* for 1858 Robert Hunt published a list of the clay pits then in operation,[12] together with the approximate annual output of each. At this time there were 107 workings in Cornwall, and a further six in Devon. During the following years the number of active quarries remained fairly constant, between 90 and 100. The number of actual pits has increased in the last 50 years, but many have been worked only intermittently or have been allowed to fill with water. Throughout this period the Hensbarrow area retained its preponderant position. The Tregonning area declined in importance and eventually ceased to produce. The Land's End area, with, at most, some five pits, has been of small importance. The small kaolinized area of south-western Dartmoor was first opened up about 1855. There has never been more than a very small number of pits here. There were a few small workings on Bodmin Moor in the mid-nineteenth century. Most of these have long since ceased production, though some new pits were opened just before or soon after the war of 1914.

[12] *Mineral Statistics*, Memoir of the Geological Survey, Part II, 1860, pp. 3–8.

THE CLAY INDUSTRY IN THE TWENTIETH CENTURY

The expansion of the industry in recent years and its present prospects are intimately bound up with geological, technical, and geographical factors, apart from factors external to the industry, such as foreign markets, American competition, and the development of new uses for clay. This paper is primarily concerned with the way in which the physical factors of a more specifically geographical nature have influenced, guided, and even controlled the industry's development.

Physical Limitations of the Clay Beds

The mode of occurrence of the clay has already been briefly described. The altered rock occurs in pipe-like masses of far from homogeneous composition, surrounded by the unaltered granite. While, in theory, there is no limit to the downward extension of the deposits, in actual fact costs rise with increasing depth, and clays of a relatively high grade are in practice the only ones obtained from the deeper pits. The disintegrated granite is washed out today by the Californian method of hydraulizing. The clay stream is freed of the coarser part of its waste products in the bottom of the pit and is then pumped to the surface for further refining. It might be urged that the increasing cost of pumping from deepening pits would be offset to some extent by the greater convenience of a stronger head of water at the bottom for sluicing the clay, higher pumping charges being offset by diminished compression charges. To some extent this probably does serve to restrict the application of the law of diminishing returns. A further problem, of a kind not met with in most forms of mining, arises. Pits have rarely been cut back into unaltered granite;

FIG. 3 (left). Hendra China Clay Works. This pit lies on the bare moorland of Hendra Downs (see map) at a height of about 900 feet above sea level. The majority of the pits are in moorland country such as is seen in this picture. (Photo by English Clays Lovering Pochin & Co. Ltd.)

FIG. 4 (right). Clay washing. This picture was made at a depth of about 250 feet from the surface. A powerful jet of water is directed at the clay rock. The stream of clay-bearing water can be seen flowing away to the left of the pipe to the sump in the bottom of the pit. (Photo by English Clays Lovering Pochin & Co. Ltd.)

instead, the walls are often composed of partially disintegrated rock, too hard, however, for economic working. An angle of rest has to be preserved in the sides of the pit, and this angle, which could approach the vertical in a granite quarry, has often, for obvious reasons, to be more inclined in a clay pit. It requires little imagination to see that this reduces the working area in the bottom of the pit unless rock of no economic value is to be cut away from the upper part. Thus a limit in depth is set by the necessity of maintaining an angle of slope in the sides that will ensure reasonable safety to the clay workers, and will afford a guarantee against "slides" which may cover and seriously injure a bed of profitable clay. It so happens, however, that the best clays tend to come from a rather harder and more resistant clay rock. Costs of working are increased, but steeper pit sides are the rule, and operations can be planned more economically.

It is apparent that, where clay deposits are closely spaced, there must be a tendency for the pits to encroach on one another. Where a large, irregularly shaped bed was first opened up by two or more companies, each operating a separate pit, it is clear that, sooner or later, their workings will merge into one large excavation. This has, in fact, happened on a not inconsiderable scale. Many pits with the same name, distinguished by an "Upper" or "Lower," an "East" or "West," or a "Great" and "Little," are now lost in one large pit. Where separate ownership may have survived, a steel wire, drawn across the pit, divides one property from the other. On Caudledown, perhaps the extreme example of this intergrowth of clay pits, five original workings have merged themselves into one immense excavation, half a mile long and 300 feet deep.

Related to this problem of the lateral expansion of the pits is that of the disposal of their waste. In general, some 10 to 20 per cent of the clay rock is extracted as clay. The remainder goes into the spoil heaps, together with the very considerable amount of nonkaolinized granite waste. Perhaps some 95 per cent of the material removed from the pits has to be dumped on adjoining land. The coarser particles separated from the clay stream, together with the

considerable quantities of unaltered or only partially altered granite, are normally hauled direct from the pit to a waste tip. For the most economical working, the pit has to be laid out so that the waste tip has room to spread, does not cover yet untouched clay beds, and is within easy reach of the lowest part of the pit. In the state of affairs which obtained until some 15 years ago, when works belonging to independent companies pressed upon one another and even worked the same deposit, the question of the disposal of clay waste was a serious one. Examples might be quoted of small companies having to shift their spoil heaps two or even three times in the course of development and expansion, an undertaking costly at the best of times and almost ruinous to a small company. More often, however, the pit has been cut back so close to the tip that, in wet weather, the waste may avalanche into the workings.

One last problem derives from the fact, already mentioned, that china clay, unlike most other minerals, exists in several qualities, quite apart from the grade or percentage concentration of the mineral in the native rock. In general, best clays and common clays are obtained from separate pits, but, although best does not occur in those producing common, some common clay always comes from pits producing best. Here the coloration is the chief factor involved. Best and common clays normally have distinct markets, the best being put to those uses where their whiteness is of value, provided their greater costs of production can be met. If it may be presumed that the full productive capacity of both best and

FIG. 5. Rocks China Clay Works. This is a rather shallow pit. In the foreground can be seen the wooden tanks in which are carried out the first stages in the separation of the coarse waste from the clay. The smoke stacks of a number of clay "drys" can be seen in the middle distance. The tips in the far distance give some impression of the way in which the waste material is encroaching on cultivated land. (Photo by English Clays Lovering Pochin & Co. Ltd.)

common clay producing plants was used during boom years—an assumption that cannot be made of the post 1919 period—then during "slump" years, when demand has contracted, the demand for "best" is found to be less elastic than that of "common." Users of common clays can switch their demand to "best," and would do so more readily if prices were lower. The evidence of the last two depressions, and even of the trade fluctuations before 1914, is that when demand contracts, the sales of best clays diminish much less than those of common. It is impossible to measure this relative contraction within the industry because, in the first place, best clays grade into common, and the distinction is never so clear-cut as may have been suggested; secondly, because there is a distinct pottery clay, susceptible, however, of other uses; and, lastly, because the necessary statistics can only be abstracted from the records of a large number of independent companies, to which access is not likely to be granted readily. The results, however, have been clear. We see, in each depression, the failure and bankruptcy of a number of the smaller, newer companies, working mainly common clays, while the old established firms, the aristocrats of the industry, operating in higher quality beds, have survived.

There is one more result of the existence of several grades of clay. Producers of the best clay have been able, in the past, to act together to maintain prices, but any valorization scheme amongst the producers of common clays has been difficult to organize because of the difficulty of assessing the relative prices of the different grades and because the best clay producers always had a store of coarse clay which was virtually a by-product of their industry. This they could unload on to the market at any time and, often enough, at any price.

Provision of Power

The need for power-driven machinery arose in the nineteenth century when pumps were installed in the deeper pits. In almost every case, it took the form of the Cornish beam pumping engine, salvaged often enough from an abandoned metalliferous mine. Rather later, coal came to be required to dry the clay before packing for transport, and steam power was introduced for haulage. Two factors have operated to change this state of affairs: a rise in the price of coal—the beam engine was a very extravagant machine—and the fact that, beyond a certain point, no more salvaged equipment was available. The new pits opened in the rapid expansion of the end of the nineteenth century relied to an increasing extent on the ordinary centrifugal slurry pump, which was smaller, easier to handle, and operated by a small steam or producer-gas engine. Coal costs were reduced. The next step was to operate an electric generator from the steam engine. Power at once became more mobile. The moors north of St. Austell were crisscrossed by overhead cables carrying power to remote workings of certain clay companies. The final stage, achieved with amalgamation of much of the industry, has been the erection of a centrally placed power station at Nanpean from which current is carried to each of the company's pits in this area.

Experiments have been made in the use of oil fuel and of electricity for the drying of clay, and changes have been made in the planning of kilns to obtain greater economies in the use of coal, and in the introduction of electrically operated filter presses, but it remains true that coal, used a great deal more

economically than in the past, is almost the only motive force in the industry.

Technique

Methods of production have changed little since the industry was described by early nineteenth century travellers. The clay is washed out by hoses, the coarser waste is settled out almost immediately, and the clay stream is pumped to the surface. Here it is allowed to flow slowly through narrow channels, the mica "drags," where the finer particles of quartz, the thin flakes of mica, and other unwanted matter are separated out. The clay is then allowed to settle in tanks, is dried in presses and finished off in a kiln. It seems that, from the technical point of view, a degree of economy has been reached that cannot be easily improved. Most of the processes are self-operating and it would appear that the only changes at all likely in the near future are improvements in drying the clay, milling it to improve the texture, and bleaching; though the old practice of "blueing" has made purchasers suspicious of attempts to change the color artificially.

A limit was set in the past by the supply of water. Although rainfall is not conspicuously deficient in Cornwall, the supply was often very short in summer, and, in the past, the clay washing was done in winter, and the clay was dried in the summer in the open in "sunpans." Now, the water drawn off from the settling tanks is returned to the pits under pressure, and any deficit is taken from streams or from old pits used as storage reservoirs.

Transport

Some three-quarters of the total productive capacity of the industry lies within ten miles of one or other of the small ports of the Cornish coast. In the past, most of the export has gone through Charlestown, Pentewan, Padstow, and Penzance, while that from Dartmoor has used Plymouth. The "dries" were located at first close to the pits, and there was usually a long road haul to the ports. When horses and carts were used—and these predominated until the early twenties—the emphasis was clearly on those ports nearest the producing area, and Charlestown was the most important. Rail transport was used, however, to an increasing extent after the 1860's and several branches from the G.W.R. main line were built into the clay district. During the present century the tendency has been for the "railway" port, Fowey, to increase in importance relative to the "road" port of Charlestown. Pentewan has not exported any clay for many years. The organization of clay transport has had as its objective the reduction of the number of occasions on which the clay was handled. Those pits which are remote from the railway rely now on motor transport to one of the ports, usually that which is nearest. In general, the railway handles only the clay that can be loaded into the trucks direct from the "dry," without the intermediate services of road transport. Almost all "drys" built in the last 25 years have been alongside railway sidings, and as the railways cannot possibly approach the workings in the majority of cases, the liquid clay has to be conveyed by pipe from the settling pits to the "drys." This is, of course, assisted by the relative altitude of the pits. The liquid clay, in a relatively high degree of concentration, can be forced through earthenware pipes for distances of several miles. This dispersion of the plant attached to any one pit is one of the most marked features of the layout of works today and one of the major economies made in transport. But the laying down of pipe lines

introduces a further problem. They are costly and more likely to be constructed if their use is very nearly continuous. No pit could operate a pipe line to capacity, but a group of pits could use a common pipe line to a group of "drys" built alongside the railway. This is a further example of the way in which the geographical problems of the industry have called for a degree of integration amongst the many small concerns which have existed in the past.

Research and the Extension of the Uses for Clay

The previous paragraphs have sketched those features of the distribution and occurrence of the clay deposits which influence most strongly the layout of the works and the internal structure of the industry. It should have been clear that physical considerations alone justify and even necessitate the fusion of the many small companies into a single concern. Marketing considerations and the need for research point even more strongly in the same direction. In recent years the uses to which china clay can be put have expanded. Most important of these is as a filler in paper. This is followed by utilization in pottery and as a dressing in cotton cloth. Other uses are legion, ranging from linoleum to colored pencils and from Maclean's powder to cosmetics. It is certain that the clay is put to uses unknown to its producers. This opens up the whole problem of research into the qualities and uses of clay, of discovering uses for specific clays, and of adapting clays already produced to particular uses. To what extent is it possible, for example, to process the lower grade clays and substitute them for the better? Can clay, an aluminum silicate, be used instead of bauxite, the oxide, in the production of aluminum? Is it possible to meet a little more closely the exact requirements of potter, of paper, and rubber manufacturer, and of chemist? The answers, in so far as they have been found, have often only partly been made public, but these are openings which the industry is, in its own interests, examining as fully as it is able. The maintenance of a laboratory and staff of research chemists was clearly beyond the ability of the small firms, though not beyond that of the large. The larger the operating unit, the less, in general, would be the duplication of research work, the less its cost in relation to output, and the greater would be the probable progress.

FIG. 6. Mica drags and settling tanks at North Goonbarrow. The clay stream is made to flow slowly through these shallow channels. What is left of the quartz and mica is here deposited and the clay and water pass into the settling tanks, seen on the left. (Photo by English Clays Lovering Pochin & Co. Ltd.)

Industrial Organization

An adequate examination of industrial organization is beyond the scope of this paper. It may suffice to say that there may have been, in the course of the industry's history, somewhere between two and three hundred independent companies. Some have collapsed, victims of one depression or another, but most have disappeared by amalgamation with their more successful rivals. Within the present century, alone, some 120 companies have been reduced to a bare half dozen, of which one, *English Clays Lovering Pochin and Co.*, bestrides the

industry with, at a rough estimate, 85 per cent of the productive power and a near monopoly of the best clays. The argument of recent paragraphs has been the influence of essentially geographical factors on this course of development. It must be emphasized, however, that the geographical factors are far from being the only or even the most important in this process of "cartelization" or "trustification." The valorization and amalgamation schemes which have followed one another in the last 25 years form a long and complex story, in which the main factors were the sequence of boom and depression and the excess productive power of the industry. The latter resulted from the opening up of new beds and the building of fresh kilns during boom years, leading to additional production during the ensuing depression.

CONCLUSION

In the pre-1914 years output was steadily mounting. It approached a million tons in 1913, and for some years the export trade had taken almost three-quarters of the total. The largest single market had come to be the United States. The war of 1914–18 not only destroyed markets in Europe, but, owing to the higher costs and difficulties of production and export, greatly reduced that in America. The market recovered, however, and in 1925 and 1926 the exports to the United States even exceeded those of 1913. But the cutting off of supplies during the war years had stimulated the Americans to develop their own resources. These were not of high grade but could be beneficiated in various ways and at a price which the American tariff made possible. Their output increased steadily in the inter-war years, gradually replacing Cornish clays in the American market. Cornish exports to the United States began to decline two years before the peak of trade expansion, and after the beginning of the depression exports fell away to relatively very small proportions. Other markets fared less badly, but, in 1932, total exports were only half those of 1913. The markets in the Empire and in Northern Europe were actually expanding slowly during the thirties, but in the best year, 1937, the total was only three-quarters that of 1913, at a time when the potential output was probably more than double.

PROBLEMS OF LANDOWNERSHIP IN THE PHILIPPINE ISLANDS

Alden Cutshall

Professor Cutshall of the Chicago Undergraduate Division of the University of Illinois spent the year 1950–51 in the Philippines on a research grant from the U. S. Educational Foundation in the Philippines (Fulbright Program). He is the author of several articles that appeared in earlier issues of this magazine.

PROBLEMS of landownership are fundamental to the economy of the Philippines. The ramifications of these problems extend into the general economical, political, and social life of the people in such a way as to impede if not frustrate attempts at the solution of other national problems.

Problems arising from the pattern of landownership and agricultural development differ somewhat in the various islands and provinces. However, these differences are not so great as to alter the over-all pattern, for none of the provinces are completely outside the general problem.

In the Philippine Islands, as elsewhere in Monsoon Asia, the lives of the people depend directly upon the soil. Fully 90 per cent of the population derives its source of livelihood either directly or indirectly from agriculture. The 1939 Census statistics list 43.6 per cent of the gainfully employed in agriculture and 43.9 per cent in domestic and personal service. However, the latter group consists mostly of housewives. It is well to keep in mind, too, that the 43.6 per cent pertains only to those gainfully employed in purely agricultural pursuits; it does not include those segments of the population that are engaged in processing agricultural products, nor does it include the part-time agricultural workers or the wives and children of farmers who may assist more or less consistently during the planting seasons. In the Philippines much of the agriculture is a family, not an individual, pursuit; therefore, it is obvious that these statistics are misleading with respect to the number of agricultural workers.

Pattern of Landownership

The development and use of the land in any country depends at least in part upon the will and desire of the owners. Hence, the pattern of ownership may be a major factor. The predominant pattern of landownership in the Philippine Islands reveals that the best lands are in the hands of a few owners and, conversely, the majority of landowners have only small holdings and many of those on marginal or submarginal land. In some areas only a small part of the rural population is made up of people who own their lands. The position of the tenant, with regard to tenure, may be insecure. With the possible exception of the sugar areas, monetary income is definitely inadequate.

Percentage of farm tenancy is highest on the sugar and rice lands, that is, on the more level and the more fertile areas. Specifically, it is highest in Occidental Negros and the provinces on the Central Plain of Luzon. In the province of Pampanga more than 70 per cent of the farm operators are tenants. In some of

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the municipalities of Occidental Negros it is as high as 80 or 90 per cent. Reasons for this system are in part historical. A considerable portion of the rented land is held in large tracts, usually called *haciendas*. In some cases the crop is produced by hired laborers, under the direction of a farm manager, but more often these estates or *haciendas* are divided into small units and leased to individual tenants. Many of these large landholdings contain from 400 or 500 to as much as 2000 hectares, but few exceed 1000 hectares. They may be held by caciques (chiefs or datus and their families) or by the secular church or religious orders, or they may be the property of private corporations. This semi-feudal structure of Philippine agriculture is a direct result of the "latifundio" system whereby extensive areas of land were given to private individuals as rewards for service to the Spanish crown. It is this lopsided system of land holdings that supposedly has instigated the social unrest in Central Luzon and, to a lesser extent, elsewhere in the archipelago. The Central Plain is densely populated but with large estates owned by a relatively few individuals. The masses of the people living in those provinces are thereby reduced to a precarious status of share tenancy. Certainly a land system that breeds social discontent has obviously failed to meet the human needs of the citizens who must depend upon it.

There is also a high percentage of tenancy among the corn and tobacco farmers, but for the most part landholdings are smaller in those areas. This means a higher number of land owners in relation to the number of tenants, a condition which breeds less social unrest.

Farm tenancy is lowest on Palawan (only 3.5 per cent) but is also low in mountainous northern Luzon and the Ilocos provinces adjacent to it, on hilly Bohol and Samar, and in northeastern Mindanao. With few exceptions these areas have experienced little or no dissident activity (1950).

Social Factors Affecting Landownership

There is some relationship between this pattern of large landholdings and Spanish methods of colonization; this, however, is probably overemphasized. The responsibility is in part to be found in Spanish history, in part in current Philippine political and social history. It is true that much land was "grabbed" or otherwise obtained by a few individuals. It was then passed by inheritance, and the owners of good land were able to extract high rents and possibly add to their holdings as the years passed. The landowners of the Philippines have been, for the most part, the political leaders of the Islands. Then, too, there is prestige in landownership. There still is little desire or temptation to turn land into money through sale. Much of this is explained by the traditional attitude of landowners toward money. Many of them do not invest surplus income in other ventures; they spend it for better living, travel, a town house, or a foreign education for their children. They do not achieve prestige in society through the possession of money income but through ownership of farm land or urban property. Hence, there is no desire to break up large tracts of land except when death of the owner makes it necessary or convenient. There is only the desire to keep what one has and to obtain more land if possible.

Recent political and economic conditions have played an important role in the continuation of this policy. During the recent war, many Filipinos lost all personal property. The land, although

it may have been idle, was retained and eventually reoccupied by its owner. The present financial position of the Philippine government is also conducive to investment in real estate rather than other forms of property. This combination of factors, together with inflated prices for agricultural products, have caused land prices to become greatly inflated. Good rice land in Pampanga is very expensive; good sugar land on Negros is equally costly if the prospective buyer can find it for sale. The result is simply that land is too expensive to buy.

There is a final factor, not unrelated to those mentioned above. Until recently there has been a lack of desire on the part of either landowners or of government to lend momentum or impetus to real agrarian reform. Immediately after the War, however, the Democratic Alliance, a respectable parent of the present communist-influenced dissident group, campaigned for agrarian reform and supported its demands with armed action. Some progress resulted, but the militant activities of the past few years, oftentimes taking the form of terrorizing raids upon innocent individuals, is the most significant internal problem of the post-War Philippines. Any opportunity for leadership in real and continued reform has now been lost.

IMPACT ON POLITICAL DEMOCRACY

Politically this system of landholding has negated true democratic process in the Philippine Islands. A small percentage of the total population has held excessive political and commercial power over the mass of the population. The result has been a highly stratified society. There is a politically active upper strata composed of a small minority of inhabitants variously estimated at one to five per cent of the total population, an insignificant and disappearing middle class, and a large lower class which has been destined to play a very passive role in the development of political institutions and social structure. Secondly, insular isolation has hindered mutual exchange of information and ideas and has thus retarded any real and concentrated agricultural reform. A low literacy, too, has retarded this movement. The average Filipino is not truly illiterate, but his schooling has been very limited. Furthermore, even the educated Filipino, in many instances, prefers to follow rather than lead. He is perfectly content to let someone think for him when major decisions are to be made.

IMPACT ON ECONOMIC PROGRESS

This predominant pattern, in several ways, favors backwardness and semi-poverty. The cultivation of a large tract of land permits the landowners to make sufficient profits from cheap labor, although labor is considerably less cheap in 1950 than it was in 1940, and thereby encourages the use of semi-primitive methods of planting and harvest. This, of course, may result in either of two evils: (1) monoculture and attendant soil depletion, or (2) poor land utilization.

Monoculture is the concentration on, and production of, one crop. This is true in the Philippines insofar as commercial agriculture is practiced. Most farmers practice diversified farming to some degree, but these are largely the marginal producers who operate largely on a self-sufficient basis. Then, too, most so-called diversification of agriculture in the Philippines is diversified only in the sense that the farmer harvests more than one crop. It does not connote crop rotation, for rice may be planted consistently on a given tract with another area repeatedly in abacá,

still another in coconuts. It is the larger landowners who account for the cash crops around which the agricultural economy is geared. This monoculture is largely inherited from colonial days when there was some justification for an export of raw materials and an import of manufactured goods because there was no tariff barrier between Spain, and later the United States, and the dependent colony. It is now time to change this practice, but there is some reluctance to do so. This means that the import controls placed on manufactured goods, although probably necessary in some ways, result in painful experience in many instances. Monoculture may not be inherently dangerous if the markets for the crops are widespread. But this is hardly true of Philippine agricultural products. Philippine economy has, for half a century, been geared to American markets. This dependence can be expected to continue, with slight modification, at least until 1972, because of the special trade agreement (Bell Bill) between the two countries. To what extent Philippine products can compete on the world market is still unproven. The only realistic solution is suitable diversification in all parts of the archipelago.

The second, and less serious, result in the Philippines, is poor utilization of the land. Some land may be withheld from production if the price of the commodity produced is low. For the most part, this is not a major factor. In the sugar lands of Negros, for example, some land is allowed to lie fallow as a measure of restoration of fertility, and there is simply more fallow land when sugar prices are low, but in this area that is not so much a criticism as a commendable practice. In the Luzon sugar area there is more competition between rice and sugar and a low price of sugar is more conducive to an increased rice acreage. Since Central Luzon is densely populated, this practice is commendable also. That poor land utilization results from the practice of monoculture is a just criticism, however, inasmuch as the situation results in a scarcity of foodstuffs, or an unbalanced diet, or both, in local areas. The poor utilization of land, then, is largely responsible for a high ratio of malnutrition in some areas and for the necessity of importing foodstuffs even in years of good production. Only Central and Northern Luzon, Mindanao, and the Sulu group have sufficient foodstuffs, on a per capita basis, to meet the daily calorie requirements of the inhabitants. This fact becomes even more realistic when one recalls that the situation exists in spite of the fact that the population is engaged primarily in agricultural occupations.

Many Filipino leaders feel that industrialization is the only solution to the current economic and political evils. But the pattern of agricultural economy, if it does not prevent the development of a manufacturing economy, certainly is a serious handicap to its development. The agricultural economy is largely dependent upon cheap labor rather than upon scientific mechanized farming. Wages of agricultural field workers are low, seldom exceeding 2 pesos per day[1]. It follows, then, that the purchasing power of most of the people is too low to provide a real stimulant to industrialization.

Since the traditional desire to own land as a sign of social prestige and

[1] Early in 1951, subsequent to the receipt of this article, the Philippine Congress passed a minimum wage law (Republic Bill No. 603) which provides that after August 4, 1951, agricultural workers shall receive not less than 1.50 pesos per day; after August 4, 1952, not less than 2.00 pesos per day; and after August 4, 1953, not less than 2.50 pesos per day. Whether a minimum wage for agricultural workers in the Philippines is really enforceable is yet to be proven.

economic security has resulted in keeping the nation's wealth invested in land, it, therefore, is not available for industrial development. Moreover, some landowners have opposed industrialization for either of two reasons. In the first place, industry would no doubt pay higher wages and hence attract farm workers into industry. This in turn would induce higher wages for farm laborers with a resultant decrease in profits. Secondly, industrialization would result in a decline in imports which would probably cause a decline in exports and thus their position could be jeopardized. Consequently, the major source of private capital, the landowners and possibly the few major sugar planters who may not be large landowners, have not provided money for domestic industry and are not likely to do so.

POSSIBLE FUTURE TRENDS

It is probable that the large holdings will in time become subdivided among the large numbers of rural population. It may be a peaceful procedure; but it may be associated with a violent social revolution.

There are several factors that are conducive to a gradual and peaceful change, namely: inheritance, soil exhaustion, financial distress, industrialization, and governmental policy. The change associated with inheritance, although slow, can be quite significant. Soil exhaustion as a result of monoculture or lack of erosion control on steep slopes will eventually result in lowered yields and lower income. Some owners may sell depleted parcels and plant elsewhere or possibly retire. Thirdly, landowners are not immune to financial distress. Excessive living, crop failure, or overexpansion of the operation may contribute to serious indebtedness, and subsequent sale of land to retire that indebtedness. Increased industrialization and a consequent reduction of cheap farm labor will cause some of the less profitable *haciendas* to become submarginal operations. This would discourage large-scale operations. Finally, the government can adopt either of two policies. It can purchase large holdings and redistribute them in smaller parcels, as has been done in isolated instances, or it can encourage colonization on federally-owned land or on land acquired for colonization purposes. A start in the latter direction has been made in Mindanao but many of the post-War migrants into these less densely settled areas are merely "squatters." The large-scale, government-operated, rice and corn production projects in Bukidnon and Cotabato are not, in themselves, the solution.

SOME RECOMMENDATIONS

The most urgent step concerns the public domain that is potential agricultural land. Of the Philippines' total land area of 29,740,972 hectares, 11,673,968 hectares (34.14 per cent) are classified as public lands. Of this latter figure 9,029,327 hectares are alienable, or deposable public lands for homesteads, free patent, and sales application. Although it is true that much of these nine million hectares is not agricultural land, several recommendations are obvious.

First, in order to accelerate homestead and sales applications there should be more survey parties to survey public agricultural lands and subdivide them into plots of five to ten hectares each for disposition. Secondly, governmental agencies should speedily process applications so that an applicant can acquire a given tract of land within reasonable time. Concurrently, road construction in new agricultural areas should have a high priority. Roads

traversing areas of public land subdivision will provide ample stimulant to settlement in most instances.

Finally, clear land titles in older farming areas are necessary. The majority of the farm lands in the Philippines acquired during the Spanish regime, or acquired subsequently through inheritance, are without land title, and these lands can be given title only after a cadastral system of surveying and legal processes of issuing title. This is a lengthy procedure, but is necessary in order that the farmer can approach the local bank for crop loans, for without collateral or security the farmer is helpless in his attempt to secure a crop loan.

The pattern of ownership is, and for some time will probably continue to be, a major barrier to a successful solution of agricultural problems. As long as a vocal minority can profit at the expense of the voiceless majority some strife and ill-feeling will continue. At any rate most economic activity will rest directly or indirectly upon the land for many years. It is hoped that the solution will be gradual and peaceful, not abrupt and violent. Can the Philippine Government accept the challenge and guide the way to an eventual satisfactory solution?

CROFTING IN THE OUTER HEBRIDES

William A. Hance

Dr. Hance, Associate Professor in Economic Geography, Graduate School of Business, Columbia University, visited the Outer Hebrides on several occasions and carried on field work there in 1947. His "Crofting Settlements and Housing in the Outer Hebrides" appeared in the March, 1951, issue of the ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS.

THE Outer Hebrides are located off the northwest coast of Scotland from which they are separated by the Sea of the Hebrides, the Little Minch and North Minch. They extend in a N.N.E.-S.S.W. direction a distance of 136 miles and have a width varying from a few yards up to 30 miles. Only 29 of the many islands and islets are inhabited, the main ones being Lewis-with-Harris, North Uist, Benbecula, South Uist, and Barra. Lewis-with-Harris, often referred to as though it were two islands, is by far the largest of the islands and has about two-thirds of the approximately 38,000 island inhabitants.

The basis of the Outer Hebrides' economy is crofting. Crofting is a system of hereditary tenure of small patches of cultivated land combined with rights on common grazing land. The physical conditions in the Hebrides are so restrictive and the density of population so great, that the crofts of the islands are incapable in themselves of supporting the population. The crofters normally engage, therefore, in some complementary activity such as fishing, spinning, weaving of Harris Tweed, kelp-gathering, or lobster fishing. Such strength as the economy has, and considerable has been developed in the past half-century, results from the flexibility and complementary nature of the dual occupation pattern.

About two-thirds of the surface of the islands is low-lying, either rock covered and rugged, or gently rolling expanses of peat, or, along some of the coasts, sandy plains called "machars." Fiord-like sea lochs are especially numerous along the east coasts and much of the lower surfaces of the islands are studded with lakes, ponds, and marshes.

The islands have a cool temperate marine climate, characterized by one of the longest growing seasons in Britain. The length of the frost-free season is misleading, however, for the very cool spring and the relatively low summer temperatures, combined with the low percentage of possible sunshine received, mean that plant growth is slow. Rainfall varies from 40 to 45 inches in the lower areas to about 70 inches in the hills of Harris. The extremely low rate of evaporation and the increasing rainfall after the early summer are important adverse factors in cereal cultivation on the islands. Finally, the climatic element which is usually of least significance, the wind, has a major influence on the life of the Hebrideans. Because of the prevalence of gales tree growth is rendered impossible except in the most sheltered locations. Crops are affected. Salt spray from the waves smashing along the west coast is blown onto the land rendering some of it too salty for cultivation and creating dunes which must be carefully controlled. Light

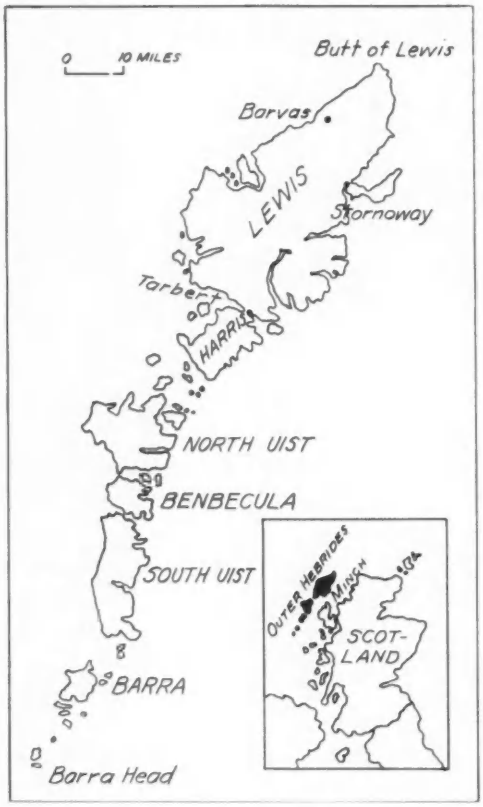


FIG. 1. The Outer Hebrides, showing the main islands and the places named in the text. Note that Lewis and Harris are actually one island, Lewis-with-Harris, although they are normally referred to as though they were two. Insert map indicates the location of the Outer Hebrides off the northwest coast of Scotland.

shell sand is blown over other areas, this time more to the benefit of the fertility of the fields. Winter winds blow in full force from September until March at an average velocity of 22 miles per hour and there are an average of from 7 to 18 days of gales in every month of the year.

As might be expected, in view of the unfavorable climatic features, the soil conditions also leave much to be desired. Peat moors cover most of the islands and the resultant soils are extremely acid and very deficient in lime, phosphate, potash, and even in available nitrogen. The soils are usually waterlogged and possess very poor aeration. Small "skinned" areas, land from which all or almost all of the peat has been removed, also have poor soil. The humus and iron compounds, leached from the upper horizon of these soils, often form a hardpan below the surface, increasing the already great drainage problems. The only areas of good soil occur in narrow stretches along the shores, particularly on the west coast, where the loose porous "machar" soil is quite well adapted to the moist conditions prevailing in the islands. Unfortunately such soils are entirely too limited in extent to meet the needs of the crofting population.

SIZE AND GENERAL APPEARANCE OF THE CROFT

The average Hebridean croft consists of a "nominal" five to ten acres of land held individually, and devoted primarily to oats, potatoes, and hay. Oats, in fact, normally occupy about two-thirds of the tilled acreage and potatoes about one-sixth. Oats and rye mixed, rye alone, or barley, may occupy another tenth; and usually, but not always, there is a tiny garden where cabbage, rhubarb, and onions are grown. The "nominal" acreage under which the croft is registered, however, does not represent true conditions, since the individual croft may have been subdivided one or more times among sons of the occupier, and cottars may reside on and use a portion of the croft. Acreage statistics tend further to exaggerate in that considerable space must be devoted to drainage ditches, which may separate cultivated rows as frequently as every four feet. There is considerable variance in the amount lost in drainage ditches between the sections of very poor soil, where the total tilled acreage on a farm is often less than an acre, and the areas of "machar" land, where

artificial drainage is not required. Acreage statistics are also distorted by the practice of recording portions of acres as full acres.

The normal form of the croft is a long rectangle lying at right angles to the road. The cottage usually lies near the road and the fields stretch out behind. Some fields may be as much as a mile in length and only a few yards wide. Where the good soil extends only a short distance inland from the sea, the fields may be only several hundred feet in depth. On the poorest soil, particularly in the hilly sections of Lewis and Harris, tiny cultivated beds may be scattered about the hillside haphazardly and may total less than a hundred square feet per croft. Drainage ditches are often used as boundary lines and in some cases are cut entirely around the croft. At Barvas, Lewis, the "machar" is limited in extent and is divided among the crofters separately so that the croft is made up of two disconnected parts.

In many townships in the Outer Hebrides, the old "run-rig" system is still in use.[1] Under this system the land suitable for cultivation is kept in common ownership and is periodically reallotted by means of a double ballot, the first ballot being drawn to see in what order drawing will be for the ballot that determines which piece of land or "rig" an individual will receive. In North Uist the "machar" land is divided into large fields called "scatts," which are in turn divided into as many "rigs" as there are inhabitants in the community. The "scatts" are cultivated in a two or three year rotation, and one or two out of a dozen may be planted to crops at any one time. "Machar" land is seldom cultivated for more than three successive years because of the danger that dunes will be formed, making it difficult to establish grass again.

The crofters' cattle and sheep feed on the grass about the cottages or on the rough pasture, except on the "machar" lands where a relatively dense cattle population is maintained. The uninhabited islands are also used for grazing, sheep occupying many of them the year round, and cattle being taken to some of the larger and more accessible ones during the summer months.

Even disregarding the exaggeration caused by unrecorded subdivision, inclusion of drainage ditches in "tilled" acreage, and the practice of recording parts of acres as full acres, the registered size of individual holdings is remarkable evidence of the crowding upon the land. In all the islands 49.3 per cent of the holdings are from only one to five acres in extent, 37.6 per cent have five to 15 acres, 9.6 per cent have 15 to 30 acres, 2.6 per cent have 30 to 50 acres, and only 0.9 per cent of the holdings exceed 50 acres in size.[2] In Lewis, two-thirds of the holdings are under five acres in size and 98 per cent are under 15 acres.

By comparison with the mainland crofting counties the density of population on the islands gives additional testimony to the pressure on the land. The density of population for all the islands is 34 per square mile; for the individual islands it varies from 61 in Barra and 40 in Lewis to 27 in the Uists and 23 in Harris.[3] These figures compare with densities of 19 and 20 per square mile in the Highland counties of Ross and Cromarty and Inverness. And the actual density on the crofting land in the most congested areas has been estimated at as much as 1000 per square mile.[4] It is apparent that pres-

[1] Alexander Carmichael: "Grazing and Agrestic Customs of the Outer Hebrides," *Celtic Review*, Vol. 10, December, 1914, p. 48.

[2] Department of Agriculture for Scotland: Parish Summaries, 1939.

[3] Census of Scotland, 1931.

[4] Arthur Geddes: "Lewis," *The Scottish Geographical Magazine*, Vol. 52, 1936, p. 302.

sure upon the land is very great. The small size of holdings with the consequent excessive pressure upon the land is, in fact, the chief cause of island agricultural problems.

THE CROFTING SEASONAL ROUTINE

The crofter's season begins in February and March with the gathering of seaweed for use as fertilizer.[5] The weed is cut with a saw-toothed sickle, bound in bundles and towed by boat to the shore nearest the croft, from whence it is transported to the fields in creels on the crofter's back. It is then spread on the fields, occasionally with shell sand that has also been brought from the shore, and left to rot.

The first ploughing of the land to be cultivated may take place as early as the end of March, though conditions are not favorable until May. The increasing rainfall as summer progresses makes it desirable to sow early, if possible, despite the fact that the cold easterly winds of April and May tend to check growth. The deciding factor concerning when to sow is often the amount of rainfall in March, advantage being taken of a dry month to sow early. On the other hand, if weather is inclement during March and April the peaty earth is likely to be too rain-soaked to be tilled and sowing would not pay.

Cultivation is performed with a spade, with a crude hand plow called a "cas chrom," or with a single-horse plough which may be used by a group of crofters and which makes quick work of the spring cultivation in the small fields.[6] On the smaller bits of land or those that require extra drainage, spade cultivation predominates. The crofters realize, in any case, the superiority of this method.[7]

May and June are the months for gathering peat, a task in which the entire family usually engages. In most cases peat is available within a short distance of the croft, although advantage is now sometimes taken of the availability of light trucks to go farther afield where the peat banks may be deeper, richer, or more easily worked. Peat on the islands varies considerably in burning qualities. Some of the best peat, usually the oldest, is black, and, when dried, is almost as hard as coal. Brown peat, more common, is comparatively soft and easily broken, burns more readily, but does not have the same heat nor lasting qualities as the black peats.

Since peat covers everything except the narrow fringes of sandy land along the seaboard, the jutting rocks, and the steeper slopes, there is no danger of the supply being exhausted; the area of "skinned" land represents but a nibbling at the total area of peat. A report prepared for Lord Leverhulme estimated that Lewis alone has 710 millions of tons of peat.[8] The plentitude of peat is in one way something of a handicap, for the price of turf is so low that it cannot be used to defray the cost of reclamation. In many areas on the continent the price received for peats is important in this respect.

The crofter is allotted a piece of ground from which he may dig all the peat he requires upon payment of a nominal sum to the owner or to the Department of Agriculture, which has, by default, become the owner of considerable land in the islands. Digging is done with a special two-sided spade usually made of steel, but the old wooden ones are still occasionally used. One

[5] Board of Agriculture and Fisheries, Great Britain: "The Use of Seaweed as Manure," Leaflet No. 254, H.M.S.O., 1915, p. 3.

[6] Colin MacDonald: "Agriculture in the Outer Hebrides," *Scottish Journal of Agriculture*, Vol. 2, October, 1919, pp. 465–474.

[7] Alexander Stevens: "The Human Geography of Lewis," *The Scottish Geographical Magazine*, Vol. 41, March, 1925, p. 82.

[8] Quoted in W. C. Mackenzie: "The Western Isles," Alexander Gardner, Paisley, 1932, p. 61.

FIG. 2. The village of Lionel in northern Lewis. This is a settlement typical of those located on low-lying and flat lands. The houses are spaced close together along the main road and long, narrow fields stretch out at right angles to the road which usually runs parallel to the coast and some distance inland. Much of the soil at Barvas is sandy "machar" land which requires no special adaptations to remove excess moisture. Unfortunately, "machar" land occupies but a small percentage of the total area of the islands.

man (or woman) usually slices off the peats, oblong in shape and about a foot long, while his companion catches them as they drop and stacks them on the surface for the first stage of drying. The stacks, which are designed to permit free circulation of air, are re-layed once or twice during the drying process. When thoroughly dry they are carried in creels by men, women, and children, to the roadside from whence they are transported by cart or truck to the croft. Here they are neatly piled near the house in solid stacks four to six feet high and covering an area of about 40 to 60 square feet. In the cottages the peat fire is kept burning at all times. Between meals a few peats will keep the fire smouldering quietly until it is ready to be rekindled; at night a wet peat is placed in the fire and covered with embers.

During the summer months when there is only occasional weeding to be done, the men engage in fishing, sometimes in gathering seaweed to burn for kelp, and occasionally in repairing the house or building a new one. There is also, for some, work on the roads, and the men engaged in weaving will normally devote spare time to this occupation rather than to fishing. The women assist in weeding the fields and take advantage of the long days to knit socks, jerseys, and underwear.[9]

The first rye grass is cut on the islands toward the end of July, and sometimes it is necessary to let it rest in the fields for weeks before it is sufficiently dry to be gathered in.

The main harvest, which is greatly dependent upon the weather, normally takes place in September or October. The potatoes, oats, and meadow hay are often harvested together, the work being performed almost entirely by hand. There is likely to be an almost daily rainfall at this time of the year so the crofters will even harvest by moonlight if conditions permit. The harvest is on no account ever made on Sunday, however.

[9] Peggie M. Hobson: "Crofting Practices in a Lewis Township," unpublished manuscript, 1948.

The winter months are comparatively quiet ones. Seaweed gathering begins, as has been noted, in February or March. Other than this, activity is devoted to weaving, the making of clothes, some fishing, and to long social gatherings.

One cannot but be impressed with the hard physical labor required on the crofts. The gathering of seaweed, the digging and transporting of peats, the ploughing and hoeing with hand equipment, the clearing of drainage ditches, the harvesting, and the sheep dipping and shearing all require considerable physical exertion. With the small size of the crofts and the relatively small number of sheep (20 to 30 per crofter), however, none of these tasks takes a very long period of time. There tend to be spurts of unusual effort, interspersed with long periods of idleness or near idleness. Furthermore, much of the work need conform to no strict time schedule. The digging of peats, for example, is often performed in the long summer evenings and may be concentrated in a few days or spread over a period of several months. Finally, the women and children perform a portion of the croft work, particularly milking the cows, caring for the chickens, weeding and hoeing, and assisting in the gathering of peats. All of these conditions mean that the demands of the croft permit engaging in secondary activities without serious loss and on a flexible basis. It is common, in fact, for one or more members of the family to be relieved entirely of croft work on a seasonal basis permitting full time occupation in fishing, or migration to the mainland, again on a seasonal basis, for employment, particularly in the fishing industry. Before the war, large numbers of island girls served as gutters and packers at the various mainland fishing centers while island men have served on Scottish east coast boats for many years.

CROPS OF THE ISLANDS

The crops grown on the Islands are limited in number and in acreage. In 1943, the total tilled acreage on the islands represented only 3.1 per cent of the total agricultural land while the total area under crops and permanent grass made up but 8.7 per cent of the area. These figures are very similar to those for the Highland Counties despite the greater density of population on the islands.[10] No less than 91.3 per cent of the total agricultural land is made up of rough grazings, generally of inferior quality. Even the value of the permanent grass varies considerably, and may include anything from a good quality meadow grass to grass that is scarcely better than rough grazing and that would, in other areas of Scotland, be classified under that heading.

Oats are by far the most important grain on the islands and, together with the other staple, potatoes, occupy 82 per cent of the total tilled acreage.[11] Oats alone in 1946 occupied 12,564 acres or almost 65 per cent of the tilled acreage. Yields of this hardy grain, which can be grown in the poorest soil, are always low, and, if the season is unusually wet, may be very poor indeed. The average yield per acre of oats on the islands is, in fact, less than half the yield of about 50 bushels per acre for Scotland as a whole and about a third of the high yield of 71.5 bushels per acre for the Netherlands.

The growing of barley, which is rather unusual for such wet islands, is possible only on the "machar," where excessive moisture drains away quickly. Barley is of greatest importance on the "ma-

[10] Agricultural Survey for Scotland, 1946, Table 1, p. 27.

[11] Department of Agriculture for Scotland: Parish Summaries, 1946.

chars" of the Uists where it occupies 7 per cent of the tilled acreage, though some is found on similar soil in northwest Lewis and near Stornoway. Although the sandy soils, together with the early summer rainfall minimum, make possible the planting of barley, its harvesting is always a gamble, and in excessively wet years great loss may occur. There has been a steady decline in the past 20 years in the acreage planted to barley, a decline which has been partially offset by an increase in the acreage in rye and mixed grains. Much of the decline, however, represents a conversion to permanent grass, in part fostered by governmental subsidies on cattle and sheep. In 1946 a total of 828 acres was recorded as planted in barley, about half of which was on the "machar" of South Uist.[12] This acreage compares with an area of 1,528 acres in barley in 1939 and 4,439 acres in 1925.

Mixed grains, chiefly oats and rye, and rye alone, each take up about one-tenth of the tilled land in the Uists. The acreage in rye and mixed grains in Lewis and Harris is very small but has been increasing in recent years.

Potatoes are the only other crop of any great importance grown on the islands. They are grown chiefly in subsistence plots, considerably less than an acre in size, and reach their greatest importance in areas where the grain harvest is most precarious.[13] For the islands as a whole, they occupy approximately 17 per cent of the tilled acreage, the figures being somewhat higher for Lewis-with-Harris and somewhat lower in the Uists and Barra. The potato yield varies from about two tons an acre on the poor land to about six tons on the best of the "machar." This compares with an average yield of 7.1 tons per acre for Scotland as a whole.[14] Enough potatoes are grown to feed the population, but, because of the shortage of winter pasture, it often becomes necessary to feed them to the cattle in late winter, thus requiring that some potatoes be imported every spring. Spraying of potatoes to reduce blight is increasing, but should probably be made compulsory to protect the crops adequately. The crofters of the islands benefit to an extent by a governmental subsidy of £8 per acre (1948) on potatoes.

Turnips and swedes are grown on some farms, particularly near Stornoway, where they are used for feeding cattle and sheep. The increase in cultivation of these root crops, slight as it is, represents an advance in agricultural techniques and the provision of more winter fodder. The only other crops grown are a little rhubarb, onions, lettuce, and cabbage, confined on those farms where they are grown to a tiny garden plot near the cottage. Certain other vegetables could be grown under the prevailing conditions, and the garden vegetables now common could be more universally grown, but lack of information and habit have thus far ruled otherwise.

The rotation practiced is a simple one, usually potatoes alternating with oats, or potatoes, oats, barley where the last is grown. When land that has been in grass, such as the "machar" which is regularly planted to grass to protect it, is ploughed up, a subsidy of £4 per acre is paid by the government. Seeds are an expensive item and all are normally bought with the exception of potato seed. Fertilizers are also expensive, but are being used in increasing quantities, partly because of a decline in the number of cattle and therefore in the amount of available farmyard manure.

[12] *Ibid.*

[13] "Land Utilisation Survey: The Highlands of Scotland," *Geographical Publications, Ltd.*, London, 1944, p. 466.

[14] Agriculture Returns for Scotland, 1934–1938.

STOCK RAISING

The small acreage devoted to crops as compared with the acreage in grass and rough grazing reflects the fact that tillage agriculture is everywhere subsidiary to stock raising. The poor quality of the pasture and the shortage of winter feed available, however, combine to make a low carrying capacity for sheep and cattle. The widespread gross overstocking and the failure to adopt proper methods of selection and breeding further reduce the value of the product.

Sheep are raised primarily for their wool, which finds a ready market in the tweed industry. When slaughtered, the sheep are consumed locally, but it is necessary to import mutton sheep from the mainland to meet the full needs of the Stornoway market.

The predominant strain of sheep found in the islands is a Blackface variety which has a somewhat shorter and softer wool than the usual Blackface sheep.[15] The sheep, primarily due to overstocking, are generally of poor quality and disease is prevalent among them. Only very recently, and with the aid of governmental subsidies on fencing, has any widespread attempt been made to introduce systematic breeding. On the open moors, which still predominate, any effort to do so would prove futile.[16]

The total number of sheep on the islands fluctuates considerably from year to year, the prevailing weather during the lambing season being one important factor determining the sheep population. Statistics of the Department of Agriculture for Scotland indicate that the total number of sheep on the islands has more than doubled in the past decade, but no such increase is borne out by the facts. The subsidy on hill sheep, now set at 16 shillings per annum per breeding ewe, has evidently led to registering sheep which had not heretofore been counted, particularly those owned by the cottars who had no legal right to the open pasture. The statistics for the years prior to the subsidy must be considered a gross underestimation, while those following the subsidy are probably quite accurate or possibly slightly above the actual number. The sheep count, made at each dipping, is now carried out much more carefully than in the past and often under the supervision of a representative of the government.

There is now a total of about 250,000 sheep on the islands.[17] Since the sheep are pastured almost entirely on the rough grazing, there must be an average of two-and-a-quarter sheep per acre of rough grazing. Agriculture Department officials estimate that there is 50 per cent overstocking of sheep over most of the area. Highest sheep densities occur in Barra, South Uist, and Harris. As has been seen, the official "souming" is often too high, and, in any case, not followed.

Although the gathering of sheep is normally organized by the township grazing committee, each crofter usually handles his own animals when it comes to dipping, clipping, and branding. Each year, the lambs are kept, the ewe lambs for breeding and the males until they are sold in the local markets for meat after about three years. Although fleece of the island sheep are of poor quality, they bring high prices because of the demand of the Harris tweed industry and the government's decision not to apply the usual price restrictions to the Outer Hebrides.

[15] F. Fraser Darling: "Crofting Agriculture: Its Practice in the West Highlands and Islands," Oliver and Boyd, Ltd., Edinburgh, 1945, pp. 147–148.

[16] Colin MacDonald: "Agriculture in the Outer Hebrides," *The Scottish Journal of Agriculture*, Vol. 2, October, 1919, p. 468.

[17] Department of Agriculture for Scotland: Parish Summaries, 1947.

Most of the cattle on the islands are dairy cattle associated with the subsistence of the croft. The typical situation is for every croft to have one or two cows to provide milk, butter, and cheese. The breed of such cows is a mixture of Kyloe, Aberdeen Angus, Ayrshire, and Shorthorn. The quality of the beasts is poor, output is very low, and methods of milking often decidedly unsanitary.

Only in the Uists and Barra, where cattle are raised on the "machar" for sale to the mainland markets, is cattle raising of commercial importance. Most of these beef cattle are a good quality Highland breed. Mainland buyers come twice yearly to the cattle markets on the islands of North Uist, South Uist, and Barra. Upon sale, the cattle are shipped either to Kyle or direct to Oban or the Clyde. The greater importance of cattle to the economy of the Uists may be seen by the fact that the ratio of cattle to inhabitants is 1.25 to 1, whereas in Lewis-with-Harris it is only .29 to 1.

Both dairy and beef cattle are fed largely on permanent grass, and in winter on hay. In some parts of the islands the cattle are housed inside all winter, feeding stuffs consisting of crops grown on the crofts in the summer. Again, governmental subsidies help out. In 1948 the subsidy on the hill cattle was £7 for breeding cows, £4 for one-year-old steers, and £3 for one-year-old heifers.

In Lewis, the practice of summer "shieling" is still carried on, the last place in Britain where it is.[18] Under this system younger members of the crofting villages take the cattle to the moors during the summer months and live in crude stone and turf huts. This practice permits the grass in the vicinity of the crofts to grow for winter feed. A cheese somewhat like a mild cottage cheese is made during the "shieling" season, which comes to a close shortly before the harvest time. In some townships "shieling" is now carried on with an important difference, namely, that daily visits are made to the grazings by bus in place of the former practice of taking up summer residence there.

The marked shortage of winter feed is actually the chief handicap to both sheep rearing and cattle raising on the islands. Both cattle and sheep are usually kept on a maintenance or submaintenance winter feeding which weakens them, increases their susceptibility to disease, and results in their being in very poor condition when the market is at its height. It also frequently makes it necessary to purchase stock in the spring when prices are high, while they are mostly sold in the fall when prices are low.

Poultry are kept on almost every croft and their importance has increased in recent years as the price for eggs advanced, making possible the shipping of eggs from the lower islands to the Glasgow area.

The suggestion has been made many times that pigs be introduced to the islands, but a deep-seated and unexplained prejudice exists among the islanders, who refuse to keep them. Repeated efforts to interest the islanders in pig-rearing have been unsuccessful.

THE CONTRIBUTION OF CROFTING TO THE ISLAND ECONOMY

The difficulty of measuring precisely the contribution of crofting to the economy of the Outer Hebrides must be apparent from the foregoing account. The total amount paid annually in subsidies to the islanders is not available, and it is difficult to assess the value of crop output and of produce consumed on the croft. The quantity of wool produced on the islands and the number

[18] F. Cecil Curwen: "The Hebrides: A Cultural Backwater," *Antiquity*, Vol. 12, September, 1938, pp. 237 ff.

FIG. 3. Closely drained fields and peat banks on the island of South Uist. On the water-logged peat soils, typical of most of the islands' area, it is necessary to space drainage ditches as close as every few feet. Peats have been dug in the second field and have been placed on the surface for preliminary drying. Beyond lies a tidal marsh.

FIG. 4. Cattle grazing on good quality permanent grass in western Barra. Here the addition of shell sand has enriched the "machar" which is used primarily for grazing beef cattle. The raising of beef cattle is more important in the Uists and Barra than in Lewis-with-Harris and cattle are shipped each year to Oban or the Clyde from these islands. Note the absence of trees in all of the views. Due to the strong winds trees are found only in the most protected spots on the islands.

FIG. 5. A "black house" on Lewis. Constructed of thick, dry stone walls with insulation between and having a thatch roof anchored by rocks these old houses show a remarkable adaptation to the physical conditions of the islands but are deficient from the sanitary viewpoint. The name "black house" is derived from the interior appearance where peat fires and poor ventilation often led to a black smudge accumulation on the walls and roof. Fresh peats are piled in the yard for use in the following winter.

FIG. 6. Croft house in the hilly section of Lewis. Only in a few parts of the islands has it been possible to locate houses in such partially protected spots, as the bulk of the settlements are along the exposed Atlantic coasts where "machar" soil is found.

of cattle and sheep sold is also not known. The Lewis Association estimated that the total value of agricultural production on Lewis was £195,055 in 1938, or £49 per croft.[19] The Association estimated for the same year that the fishing industry brought £261,529 to Lewis and the tweed industry £307,024, ranking crofting third in importance as a producer of income for that island. With the continued rise of the tweed industry, and with high prices being received for fish, it is likely that the relative importance of crofting on that island has declined still further.

High prices also prevail today for whatever excess is available from croft production, making it likely that the estimate of £49 total value of agricultural production per croft is now quite low. Crofting is also relatively more important in the Uists, where the average acreage per croft is higher than on Lewis. Extrapolating from the Lewis Association estimate and taking into account such items as the number of cattle and sheep in the remaining Hebridean area, the number of families, the rise in prices, and the average size of holdings, a rough estimate of the total value of agriculture for the Hebrides might now (1949) be £560,000 or about £70 per croft. This figure does not represent cash income from the croft and even if it did it could not be considered sufficiently large to permit the crofters' living on a satisfactory standard.

Expenses of crofting include rent and taxes, both very nominal, the cost of seed and fertilizer, plus whatever food and clothing items are not produced on the croft. The fact that the present tendency is to buy an ever-increasing proportion of foods from shops and from grocery trucks indicates that the cash income of the crofters is materially increasing.

The croft, then, with all its inadequacies and obvious shortcomings, provides very considerable strength to the island economy. It provides directly such food items as milk, butter, eggs, cheese, potatoes, vegetables, grain, and meat. Studies that have been made of the diet of the islanders indicate that, though it is lacking in variety, it contains no serious nutritional deficiencies. There is and always has been a shortage of vegetables in the diet and at present there appears to be a slight decline in the availability of milk but neither of these factors are considered dangerous. In addition to food, the croft also provides wool for clothing, thatch straw and rocks for shelter, and peat, valued in 1938 at £24 per croft per year,[20] for fuel. Such products as beef cattle, mutton sheep, wool, eggs, and milk are produced in excess in varying degrees providing cash income through sale and subsidy. And finally, by retaining their status as crofters, the islanders are eligible for other benefits in the form of Department of Agriculture loans, the protection of the Scottish Land Court, and rigidly limited rental and taxation rates. It is little wonder that the crofters have repeatedly refused to abandon the crofts to promote a full-scale industrialization in the islands, that they have preferred to engage in secondary occupations retaining the security of the crofting base.

CONCLUSIONS

There can be little doubt of the need and of the room for improvement in crofting conditions and practices. Measurable benefit can be obtained without large expenditure and without requiring revolutionary changes. The extension of the practice of enclosing the arable

[19] Lewis Association: The Lewis Association Reports, Report I, The Highland News, Ltd., Inverness, 1945, p. 14.

[20] *Ibid.*, p. 14.

portion of the croft, for example, would permit protection of crops, and encourage the growing of additional vegetables to relieve the monotony of the diet. Carrots have been found to do reasonably well on drained peat and would provide a welcome addition to the diet. Crofts which do not at present grow onions, rhubarb, lettuce, and cabbage could be encouraged to do so. Proper rotation methods, involving the use of leguminous plants, should also be fostered, particularly in connection with the cattle industry of the Uists. Spraying of potatoes to reduce blight is another real necessity, and its practice should be widened and possibly made compulsory. Again, much greater use could be made of seaweed as a fertilizer, and the application of more shell sand, readily available in certain areas, would render peaty soils more workable while at the same time increasing their yield. None of these suggested improvements would involve heavy financial cost.

In connection with grazing, the subdivision of hill pastures to permit control of stocking and the introduction of scientific breeding should be extended. Already it is encouraging to see the number of grazing committees which in the past few years have taken advantage of the governmental subsidy on wire to erect grids enclosing portions of the moorland grazing area. The problem of overstocking is a serious one and it is, unfortunately, prolonged, if not increased, by governmental subsidies on sheep and cattle population which are extended without reference to quality of the product. These subsidies should be altered to eliminate their present pernicious influence and, at the same time, to encourage proper breeding and stocking practices.

Croft housing is another area where present conditions leave much to be desired. Considerable improvement can be made at minimum expense if local materials are used in erecting new houses or rehabilitating old ones. The provision for proper sanitary facilities, a clean water supply, and adequate drainage are essentials. The schools could very likely be utilized to advantage in educating the younger inhabitants concerning the reasons for and the need of improvements.

Even if all of the improvements suggested were adopted by all of the crofters, however, the very great problem of congestion upon the land would remain. The size of the crofts and the low productivity of the soil can mean only that the croft holding as a self-supporting unit is generally uneconomic. The Highlands and Islands Commission of 1938 and the Lewis Association both state that the crofts under present conditions are incapable of supporting the population which occupies them. As far back as 1886, the Napier Commission estimated that the minimum size of a croft was 10 acres of arable land plus 27$7\frac{1}{2}$ acres of pasture. The average share of pasture in the islands is now less than a third and the acreage tilled less than half of the recommended areas. Nor does it seem possible to remedy the situation by reclaiming some of the low-productive peatlands presently classified as rough grazing.

Not only do the crofters themselves have insufficient land but the cottars and squatters present an additional difficult problem—from the agricultural standpoint almost a hopeless one. Legally and in principle, the subdivision of crofts and the practice of squatting are indefensible. They create smaller holdings from crofts which are already too small. The houses erected need not conform to regulations, and, hence, are often the poorer and less sanitary dwellings, and the squatters receive full advantage of local services with no

payment of taxes. Yet the solution to the problem is perplexing if, short of forced evictions, it is possible.

The fact that the crofts of the islands cannot be considered self-supporting farms must be emphasized. Despite the unanimity of opinion regarding the small size of croft holdings, there has never been a general acceptance of the fact that the island agriculture could not be counted upon somehow to maintain the population at a decent standard of living. The croft is more akin, in fact, to the continental laborer's garden, and, just as the latter individual must earn his living at some other job, so the average crofter must supplement his living, though to a lesser extent, in some other occupation. The existence of a croft which supplies the families' needs for meat, vegetables, grain, milk, butter, cheese, eggs, and wool means that the basic needs of the crofter are produced at home. The remaining necessities, however, must be paid for by work in some other area. The conclusion, therefore, is that the prosperity of the islands depends upon industries other than crofting. If they fail, we cannot look to the crofts to absorb the strain. As long as the pressure of the crofting population, increased by that of the cottars and squatters, continues at the present high level, the crofter will be a fisherman-crofter or a weaver-crofter, and one or more of his sons and daughters will probably be forced to migrate, at least on a seasonal basis.

THE HO-SI CORRIDOR*

Liu En-lan

Miss En-lan of Nanking, China, spent four months in Lanchow in 1944 and travelled through eleven of the counties of the Corridor.

NEAR Lanchow on the upper Yellow River in northwestern China the lofty mountains known as the Nan Shan split into lesser ranges that gradually die away to the east. North of the Ki Lien Shan, one of these branches, lies the Ho-si Corridor which has served for centuries as a passageway between the upper Yellow River country and Dzungaria and the Tarim Basin. The presence of this trough-like valley between the Mongolian Desert and the Tibetan Plateau may be readily detected on the political map of China by noticing the long northwestward extension of Kansu. The Province of Kansu projects a narrow tongue between the neighboring provinces of Ningsia and Tsinghai. And this projection contains the Ho-si Corridor.

Location of the Corridor

For statistical purposes the Ho-si Corridor can be defined as that part of Kansu lying west of the Yellow River. The name Ho-si comes from the joining of two words, "ho" meaning river and "si" meaning west. Together they mean "west of the river."

Actually, to reach the Ho-si Corridor from Lanchow one crosses the Hwang Ho bridge and travels 130 kilometers to the northwest. It is necessary before reaching the Corridor to cross the Wu Chiao Ling by way of a pass 3000 meters above sea-level. From this point the lofty (4000 meter) snow-capped Ki Lien Shan stretches away to the northwest and marks the southern edge of the Corridor. To the north of the Corridor lies the Ho Li Shan, a lower range. The trough of the Ho-si Corridor extends northwestward between the mountains for 1000 kilometers, gradually descending from 1600 meters at its southeastern end to 905 meters at its northwestern extremity.

Upon crossing the Wu Chiao Ling from Lanchow one enters a new world. The southeasterly rain-bearing winds are left behind, and a land of interior drainage is entered where the soil is charged with alkalies. None of the streams of the Ho-si Corridor reaches the ocean. The larger streams empty their waters into lakes and basins, and the smaller streams lose themselves on their way into the deserts. The higher mountains are covered with forests, and their lower slopes are green with grass, but the floor of the Corridor itself is a monotonous barren yellow earth.

The People

In spite of inhospitable climate and precarious setting, more than a million people make their homes in the Ho-si Corridor. This number seems high from a Western point of view, but for the Orient it is low. This low population density, less than six per square kilometer, raises the question: Why after 2000 years of colonization is the Ho-si Corridor still underdeveloped and underpopulated? Apparently colonization of this area took place as long ago

*Manuscript received in 1948.

as the Han Dynasty, about the second century before Christ. A few years ago when the motor road was being constructed through the desert area west of Changyeh many ruined buildings were found buried in the sand. These are thought to date back to the Han Dynasty, but no one can be sure, for the records are partly lost and events are blurred by time.

The people of the Ho-si Corridor belong to five major groups. There are last group was originally Buddhist and later embraced Islam. In all, the people of the Ho-si Corridor speak five major languages and subscribe to four major religions: Islam, Lamaism, Buddhism, and Confucianism.

ECONOMIC HO-SI VS. EMPTY HO-SI

The part of Kansu Province that makes up the Ho-si Corridor has been divided for administrative purposes into two districts, the Sixth and the Seventh

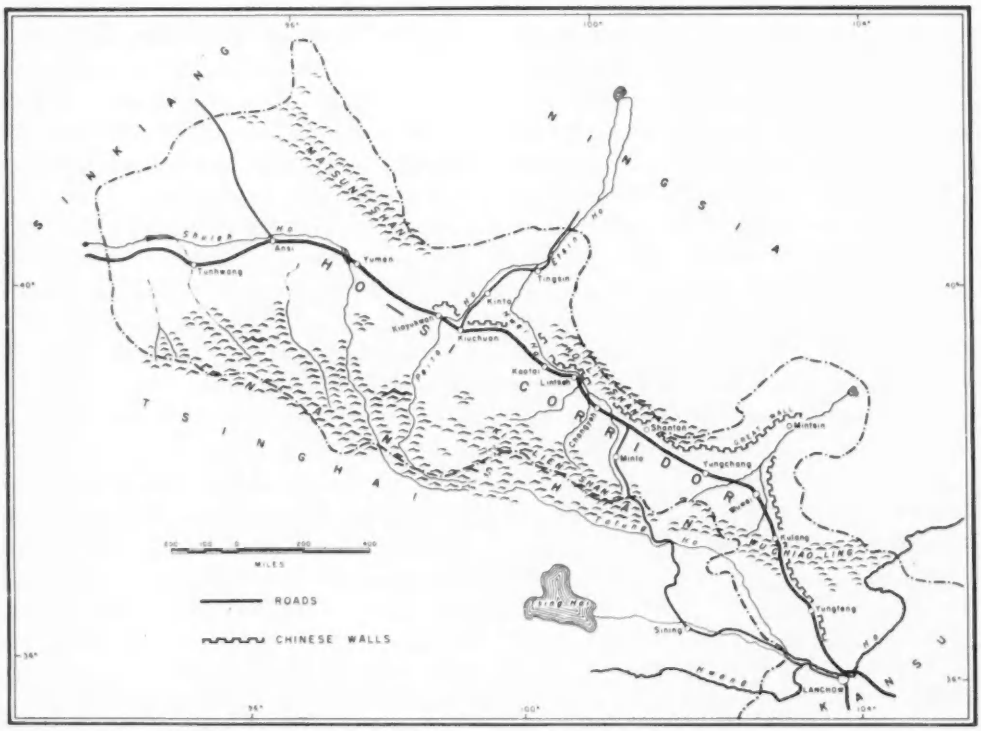


FIG. 1. The Ho-si Corridor hemmed in by mountains lies in a northwestward extension of Kansu Province.

(1) the Fan, a group of highland or Tibetan shepherds; (2) the Mongols, a nomadic people of the desert; (3) the Han Ren, a people from the Yellow River valley; (4) the Hossaks, a nomadic people from Central Asia who are Moslems; and (5) the Uighers, a Turkish group who were deported from Kashgaria during the eighth century and who settled in Kansu and Shensi. This

(Fig. 2). The Sixth Political District lies at the eastern end of the Ho-si Corridor and is further subdivided into eight hsiens. Hsiens are comparable to American counties. The Seventh Political District lies farther west and is subdivided into seven hsiens. From Table I it can readily be seen that the Sixth Political District is only one-third as large as the Seventh Political District,

but it contains three-fourths of the people of the Corridor. The greater use of the Sixth District can be inferred also from Figure 3 which shows the population density pattern and it is reflected in Figure 4 which shows the percentage of cultivated land in each hsien. cultivated areas outside of Kiayukwan are mostly desert.

Kiayukwan is the outpost of the better settled area. Beyond this point Chinese are reluctant to go. They have a saying, "Stepping out of the Kiayukwan, one's eyes are never free from

TABLE 1

ECONOMIC DATA FOR THE HO-SI CORRIDOR

Hsien	*Area in sq. km.*	*Population*	*Population per sq. km.*	*Per Cent of Total Land Area Cultivated*
The Sixth Political District				
Wuwei	7,048	339,659	48.1	9.9
Changyeh	3,712	169,376	45.1	12.0
Mintsin	9,555	103,229	10.8	2.1
Yungchang	12,123	45,938	3.8	3.4
Shantan	6,136	35,364	6.0	4.9
Minlo	1,553	32,222	20.7	24.4
Lintseh	2,362	47,537	20.1	9.4
Kulang	3,017	37,115	12.3	9.6
Total	45,487	810,440	17.8	
The Seventh Political District				
Kiuchuan	8,751	120,669	13.7	5.0
Kaotai	6,135	61,912	10.1	1.8
Ansi	33,522	20,278	.6	.3
Tunhwang	64,178	30,457	.5	.2
Yumen	15,062	28,747	1.9	1.4
Kinta	6,002	25,736	4.2	1.0
Tingsin	1,584	12,428	7.9	1.2
Total	135,254	300,227	2.2	

Actually the economic divide between the eastern, better-used Ho-si Corridor and the western, lesser-used Ho-si Corridor does not quite coincide with the political boundary between the Sixth and Seventh Districts. The economic divide falls in the hsien named Kiuchuan at a fort called Kiayukwan. That part of the Ho-si Corridor that lies to the east of this line is known as the land "inside Kiayukwan" and the land to the west is said to be "outside Kiayukwan." The percentage of cultivated land inside Kiayukwan is notably higher than that outside Kiayukwan. Moreover, the uncultivated land inside Kiayukwan is very largely steppe and is a possible pasture area, whereas the un-

streaming tears." It means that people feel sorrowful when they leave the familiar cultivated fields to venture into the unknown. Just outside of Kiayukwan, there is a tiny, shallow cave into which travellers used to throw pebbles before they left the fort. Superstition says that if an echo is heard the traveller will return alive; when no echo is heard, it signifies that the traveller will not return alive. This superstition indicates how reluctant the people have always been to venture into the unknown beyond Kiayukwan. In this way they tried to strengthen their courage with an omen or to secure an equally strong reason for returning to their old homes. In reality the Ho-si Corridor outside

Kiayukwan is not at all dreadful. The sandy wastes are dotted with oases. And if one goes far enough to reach Tunhwang, the westernmost hsien of Kansu, he finds an area as attractive as parts of eastern China.

The Chinese government has tried repeatedly to colonize the Ho-si Corridor with farmers from the crowded flood plains of eastern China. But Chinese farmers have not flocked to the area. The government has even resorted to forced migration by Imperial decree, but without success. Little was done to make the area more habitable for these settlers. The people were not given adequate knowledge of farming methods best suited to the new environment, nor were additional irrigation projects developed which might have helped to support a larger population. Consequently, when crops failed the Chinese farmers returned to eastern China in search of food, abandoning their Ho-si Corridor farms.

During the war with Japan, when northwestern China became a cornerstone of resistance, attention was called to the Ho-si Corridor. More recently, during the Civil War in China, refugees from eastern China flowed toward the northwest. The Ho-si Corridor is particularly important at such times, for it is an important gateway between Szechwan and Sinkiang. A motor road was built along the old caravan route through the Ho-si Corridor during the war with Japan, but still permanent settlers have been reluctant to come to the area.

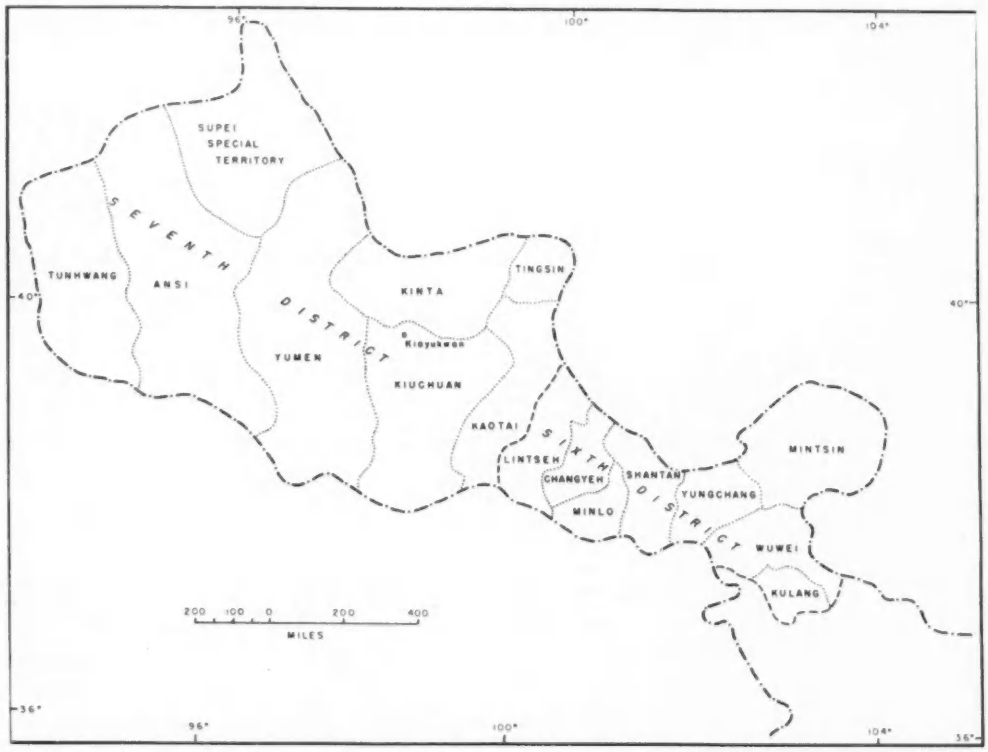
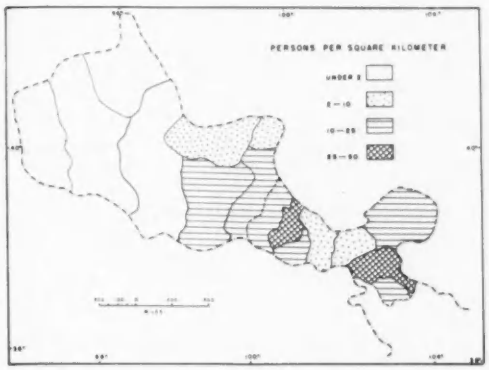


FIG. 2. Political structure of northwestern Kansu. The smaller divisions are hsiens, comparable to American counties.



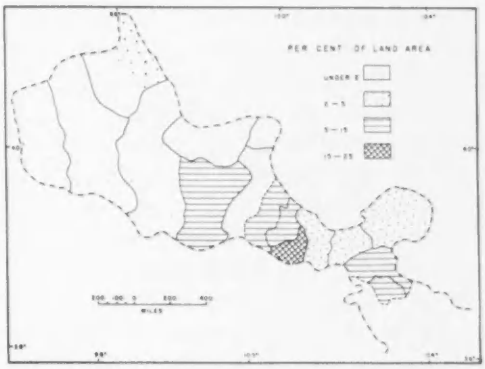


FIG. 3 (left). Population density by hsiens.
FIG. 4 (right). Cultivated land, proportion by hsiens.

RESOURCES OF THE HO-SI CORRIDOR

The Ho-si Corridor has been more important as a transit land than for its resources. But the cultivation of crops under irrigation has been part of military strategy. Whenever the oases of the Ho-si Corridor are productive, the farmers are prosperous and can supply food for the army. When the army is strong, there is good order and peace. When crops fail and food is scarce then the army is weak and there is chaos.

In spite of the low percentage of cultivated land and an agriculture that is both difficult and precarious, the Ho-si Corridor usually produces enough to feed itself and to have a surplus for export to other regions. This is due to the low population density and is an indication that the region could in truth support a denser population. Wheat is the chief crop for all the counties. Barley, millet, beans, and sweet potatoes are fairly important food crops. Kaoliang, buckwheat, corn, oats, and rice are also grown to some extent. In addition to food crops, cotton, wool, and tobacco are produced. Statistics for this part of China are skimpy and irregular, particularly so since the area devoted to each crop and the amount of production vary greatly from year to year.

There are no forests on the floor of the Ho-si Corridor. The only trees one sees are the willows and poplars along the roads and ditches. There are also a few date palms and some fruit trees in the oases. However, in the Ki Lien Shan there are forests which are only a little known and have not been touched. The forests are actually not far up the mountain valleys. Only a few tens of miles up the valleys brings one to good forests. What is needed is a scientific survey of these resources and a better method of transporting the wood to the outside world.

Wool, hides, and skins are the chief cash products of the Ho-si Corridor. The most important centers for wool collection are Yungten, Yungchang, Changyeh, and Kiuchuan. These centers are all in the eastern part of the Ho-si Corridor.

The geology of the Ho-si Corridor is not fully known, but minerals of value appear to occur widely. They are being mined only in small quantities, however, and by crude native methods. Gold, silver, copper, and lead are found in the gneisses and schists of the region, and in the quartz veins that penetrate these rocks. Two mineral resources are found

in important quantities: salt and petroleum. In this naturally dry region, salt can be found almost everywhere. In some places the people do not need to buy any salt from the markets. They can pick up what they need from areas where it has been left by evaporation. Where more salt is needed it is easily concentrated from the brines of brackish ponds. The methods used are crude and impurities are not eliminated. For this reason it is not considered to be very good salt. The resources of salt are great, but as yet they are largely undeveloped.

Perhaps the greatest mineral resource is petroleum. The oil field at Yumen was developed only recently, after the beginning of the war with Japan. Oil is found in a sand layer below the Tertiary strata at a depth of about 500 meters. Wells are drilled on the slopes and tops of small anticlinal hills near the foot of the Nan Shan. Oil reserves seem to be rich, although the exact quantity is still unknown. The oil rushes up without pumping but due to a lack of pipes and barrels it is largely wasted. Although there are small refineries nearby no adequate transportation for oil has been provided. It seems likely that the oil reserves of Kansu are extensive, but only a limited amount of drilling has taken place so far.

The Ho-si Corridor is not noted for any industrial development as yet. The only developments are chiefly home industries making things that are used in the homes. Cotton cloth is made at Kaotai and Mintsin and there is a little woolen weaving at Kiuchuan. The raw materials that might be used for industrial development are wool, skins, cotton, salt, and petroleum.

In traversing the Ho-si Corridor from east to west one passes through a succession of oases. The eastern ones are mostly large, averaging three or four hundred square kilometers, but the western oases are smaller. Between the oases are smaller settlements where former military stations existed and where now a few houses remain to serve as inns or rest houses for travellers. There are only a few scattered farmsteads on the steppe lands between the oases. In the lonely wilderness between human habitations one travels with the Great Wall as a constant companion. The new motor road winds back and forth in its efforts to avoid irrigation ditches, but never leaves the wall completely until the wall itself dies out in the desert.

THE FUTURE

In travelling through the Ho-si Corridor in 1944, the writer came to the conclusion that the resources of the Corridor warranted much better use of the area. It would seem that the present population of a little more than one million might easily be trebled. The irrigated areas might very well be increased, and better use could be made of the steppe lands. Long stretches of steppe were observed without any inhabitants other than antelopes. It is to such lands that officials should turn their attention when they attempt to settle more people in the Ho-si Corridor.

DELIMITING THE MAIN LINE DISTRICT OF PHILADELPHIA

George Langdon

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ONE of the greatest difficulties in discussing geographic regions is that of accurately and logically confining the area to definite boundaries. Limits of regions are too often arbitrary and poorly defined. Frequently there are good reasons for using an indefinite boundary, but study and description are always facilitated if it is possible to draw exactly the limits of the area in question.

This study attempts to present a simple method of logically bounding a somewhat indefinite region. The region used for illustration is one that exists chiefly in the imaginations of people; consequently, various individuals have different concepts as to the actual extent of the area.

The sample region utilized is the residential area known as the "Main Line District" lying west of the city of Philadelphia. The region represents a rather typical residential suburban growth along a major artery of transportation leading from a large metropolis. It derives its name from the fact that it lies along the *main* route leading westward from the city (Fig. 1). The Main Line tracks of the Pennsylvania Railroad and the four-lane Lincoln Highway are at present the principle arteries of transportation, although the extension of the Pennsylvania Turnpike may alter the picture in the near future.

The Main Line District is an area that abounds in wealth, prestige, and history. It possesses the natural advantages of a comparatively high elevation, picturesque scenery, and pure wholesome air. The beautiful rolling countryside is dotted with large estates and expansive country places of prominent, distinguished socialites (Figs. 2 and 3); scattered among these wealthy residences are a few full-time farms with buildings more typical of rural Pennsylvania. In contrast, the communities are composed of people possessing smaller residences; some of them are structures of grace and beauty while others are antiquated, obsolete houses belonging to times gone by. Well paved roads meander among the estates and connect the communities, giving the area a certain compactness that in many ways isolates it from the remaining vast suburban residential district surrounding the city of Philadelphia. "Everywhere in the suburban country the effect of the city is visible—in the many commuters among the residents; in the industrialization of the towns, their specialties often like those of Philadelphia; in the park-like appearance of the country estates; and in the constant streams of traffic flowing to and from the metropolis on the Delaware."[1]

The result is a blending of residential suburb and well kept country homes not too commonly found, earning for the area a reputation as an excellent place in which to live. Most people living anywhere *near* the area in ques-

[1] Raymond E. Murphy and Marion F. Murphy: "Pennsylvania: A Regional Geography," Harrisburg, 1937, p. 202.

FIG. 1. The main line tracks of the Pennsylvania Railroad and the four-lane Lincoln Highway have been, until the present, the principal arteries of transportation in the Main Line District.

tion *like* to consider themselves "Mainliners." The prestige associated with residence in the area has caused the Main Line to develop more or less elastic boundaries that vary according to the whims of the inhabitants.

This study attempts to confine this indefinite area by contrasting several maps showing the boundaries as they would exist based on various criteria, and then by *superimposing* these maps one upon the other. In this manner, a boundary for the region is established.

THE FIRST MAP OF THE AREA

The present "Main Line" coincides with the general location of the area known in colonial days as "The Great Welsh Tract." This was originally set aside for the unhampered development of a Welsh utopia by William Penn. When he induced the Welsh to purchase this land in 1678, he intended that it be laid out contiguously as one barony capable of conducting affairs separately from the rest of the colony. It was to have a definite boundary line which was to act as a barrier excluding other peoples and their customs. Unfortunately for the Welsh, Penn had not defined the area accurately. All they knew was that it consisted of about 40,000 acres lying west of Philadelphia and that it was to be known as the "Welsh Tract."[2] This disturbed the Welsh until their antagonism led Penn to direct Thomas Holmes, his surveyor general, to lay out the tract in 1684. Figure 4 shows the approximate boundary lines of the territory covered by the "Great Welsh Tract" superimposed upon the presently existing township lines. The tract's boundaries, as shown on the map, were determined through a study of the original map by Holmes and by other supporting data.[3] It must be remembered that the original map by Holmes was rather haphazard and mostly an outline. There is a great deal of mystery surrounding the date of its origin, yet it is interesting and valuable since it gives the first basis for limiting the area now known as the "Main Line."

Although William Penn had originally intended to keep his promises to the Welsh, he was prevented from doing so by certain circumstances beyond his control. One of the most serious difficulties encountered soon after the tract was settled was one of excluding other people from the area within the stated boundaries. English settlers (and others) were encroaching on the Welsh lands, bringing their alien ideas and customs.[4] Since the "Welsh Tract"

[2] Charles H. Browning: "Welsh Settlements in Pennsylvania," 1912, p. 35.

[3] *Ibid.*, pp. 37 and 488.

[4] T. A. Glenn: "Merion in the Welsh Tract," 1896, p. 48.

had never been really recognized as an individual Barony and since Penn's agreements were not reduced to writing, opposition to these unpleasant (to the Welsh) difficulties were loud but remained legally weak.[5] This was only the beginning of trouble for the Welsh who had hoped to live isolated from outside influences. Persistent attempts were made to break up the tract between 1690 and 1691, and by 1700 the Welsh had relinquished their rights.

After this, the boundaries of the tract seemed literally to vanish. These early colonists were soon engulfed and merged with other peoples. Even if they lost their identity as a separate race, their teaching and influences were instilled into the community of strangers that grew up about them and the general location continued to be known as the "Welsh Tract" until the time of the Revolutionary War and even later.

limits reached the edges of the area the former Welsh Tract became one of the choice nearby suburbs. The main line of the Pennsylvania Railroad was built along the watershed between the Delaware and Schuylkill and passed directly through the territory. But even as late as 1860 or 1870 the dwellers of this area were principally farmers, who did little commuting, requiring only six trains a day, and none on Sundays. In contrast, today, commuter train statistics published by the Pennsylvania Railroad indicate that over 100 trains serve the 16,360 daily commuters.

For many years this was a backward and obscure place to the people in the nearby thriving city of Philadelphia, as expressed in the historical address of Mr. John W. Townsend entitled "Then" before the annual meeting of the Community Health and Civic Association on January 31, 1927. It was only after

FIG. 2 (left). Country estate near Sugartown in the Main Line District.

FIG. 3 (right). Country estate near Bryn Mawr in the Main Line District. Note that both this house and the one near Sugartown are on hilltops, a characteristic feature of country homes in this region.

EMERGENCE OF THE PRESENT MAIN LINE DISTRICT

With the disappearance of the Welsh Tract as a distinct area in the Province, this territory existed for decades without a distinct name or a definite boundary. As the city of Philadelphia grew and its prominent Philadelphians began to spend their summers at the old boarding houses along the main line of the railroad that the expression "Main Line" originated. At first, those Philadelphians who moved out on the "line" did so to get away from the hot summers in the city; they stayed for a month or two at "Boarding Houses," returning to the city for the winter season because of

[5] Browning, *op. cit.*, pp. 26 and 337. Also, Glenn, *op. cit.*, p. 24.

the greater convenience attending the social doings. City dwellers at that time had the idea that those who lived in the suburbs the year round were yokels, and it was only after improvements in transportation that permanent residence there was considered preferable to that in the city.[6] Soon, however, many of the social notables removed themselves from the city and established their residences permanently in this area which was still just "country" out along the main line of the railroad. By the time these so-called "Mainliners" arrived, little remained to indicate that this area was once the Great Welsh Tract, save for the presence of some of the old Welsh names.

In the last few years of the nineteenth century and the first few of the twentieth, the area grew amazingly. It became the site of wealthy country places and estates. The farms began to disappear and the countryside took on a different appearance. The people who came liked the solitude, the higher altitude, and the clean fresh air; they were proud of their homes and did not hesitate to mention to their friends that they lived out along the "Main Line." Soon, the expression was unconsciously accepted and applied to all territory covered by their residences. The term was like a rubber band: it stretched easily in all directions. At first these socialites confined their residences and large estates to the area within convenient commuting distance of the central city. But as time passed and transportation became better, the limits of the area were extended. This was especially true after the development of the automobile and hard surfaced roads. It became possible to live farther and farther from the track and yet be a "Mainliner."

In recent years, the tendency has been to divide these spacious estates and part-time farms into smaller plots. People, not necessarily wealthy, but able to afford the additional expense of moving from the congestion of the city into the open where they can find fresh air to breathe and a space for their children to play safely, are the modern "Mainliners." As a result, the area is gradually being built into a compact residential district of smaller homes. This tendency of breaking the large land holdings has been climaxed by the latest development of the construction of beautiful suburban apartment houses. Electric trolly lines, bus routes, frequent commuter trains, and the ability of the common man to own an automobile has expanded the area known as the "Main Line" to communities miles from the track.

THE EXTENT EXPRESSED AS A RAILROAD TERM

It is possible to interpret the words "Main Line" solely as a railroad term. According to Webster's Dictionary, the word "main" can pertain to "the trunk line of a railroad," and the word "line" can be "the course followed by anything regarded as in motion"; hence a "road or route" or "the track and roadbed of a railroad." Using this interpretation, it is possible to define the length and breadth of the main line of the Pennsylvania Railroad; it would simply extend the distance from New York City, the eastern terminus, to Chicago, the western terminus. But by adding an adjective it is possible to limit this vast stretch to a few definite miles. This study treats of the "*Philadelphia* Main Line," and confines the length to the area near Philadelphia. This can be easily further restricted to that portion of the track near the western limits of the city because at the time the expression "Main Line" was originating, the

[6] John W. Townsend: "The Old Main Line," 1922.

eastern terminus of the Pennsylvania Railroad was the city of Philadelphia.[7]

This impression, then, would limit the area to the many communities clustered along the railroad tracks. Most of the people living within these restricted bounds are within reasonable walking distance of a commuter station. This long narrow belt along the tracks composes most of the urban area and contains most of the sections with older, outmoded buildings. In many ways, this small narrow area has the most just claim to being "on the Main Line"; at least it has been so known for many years.[8]

LIMITS BASED ON PUBLIC UTILITIES

The fact that the Main Line has expanded north and south of the old railway meridian is demonstrated by a study of the public utilities serving the area. Figure 5 represents the limits of the area covered in soliciting ads for listing in the classified section of the Suburban Philadelphia Telephone Directory, issued for distribution on the Main Line. It includes the following exchanges: Cynwood-Merion, Ardmore, Bryn Mawr, Narberth, Berwyn, Wayne, Paoli-Malvern, and Newtown Square. The area around Newtown Square probably has the least justification for being included. All the other exchanges mentioned not only represent the areas covered by the Main Line classified section but also indicates the territory covered by the Main Line servicing division. The Newtown Square Exchange, however, is serviced by the Upper Darby Division, which is considered separate by the Bell Telephone Company.

The limits of another public utility in the area is indicated by Figure 6. It represents the territory served by the Main Line Division of the Philadelphia Electric Company. Note that the area covered by this division includes the townships of Upper Darby, Haverford, Lower Merion, Radnor, Upper Merion, Marple, Newtown, Easttown, Tredyffrin, and Willistown in addition to the boroughs of Millbourne, Narberth, and Malvern.

The area considered Main Line by the Philadelphia Suburban Water Company is represented by Figure 7. The territory served by this company is divided into three sections: The Eastern, Southern, and Western. The area outlined in the figure is the Western Division, which is the section known as the Main Line by the company.

DISTRICT BOUNDARIES FROM REAL ESTATE ATLASES

A study of several property atlases published for the use of Real Estate firms on the Main Line indicates another possible basis for limiting the area (Fig. 8). Street and house number indexes of the area and accompanying location maps proved valuable in determining this boundary.

PUBLIC OPINION AS A BASIS OF DELIMITATION

Figure 9 is a map that proposes to indicate the possible extent of the area occupied by people who consider themselves as Mainliners. It is a demarcation that might be called a "social" boundary. It was determined by combining many opinions and observations. Signs were observed on banks, drug stores, and other places of business with the expression "Main Line" in their title. Want Ads of real estate for sale listed as Main Line property in the Philadelphia newspapers were checked against society columns relating events of Main Line families. People were approached with questions by correspondence and

[7] Guide for the Penna. R.R., 1855.

[8] Douglas Macfarlan: "The Main Line in Colonial Times," 1941. Introduction.

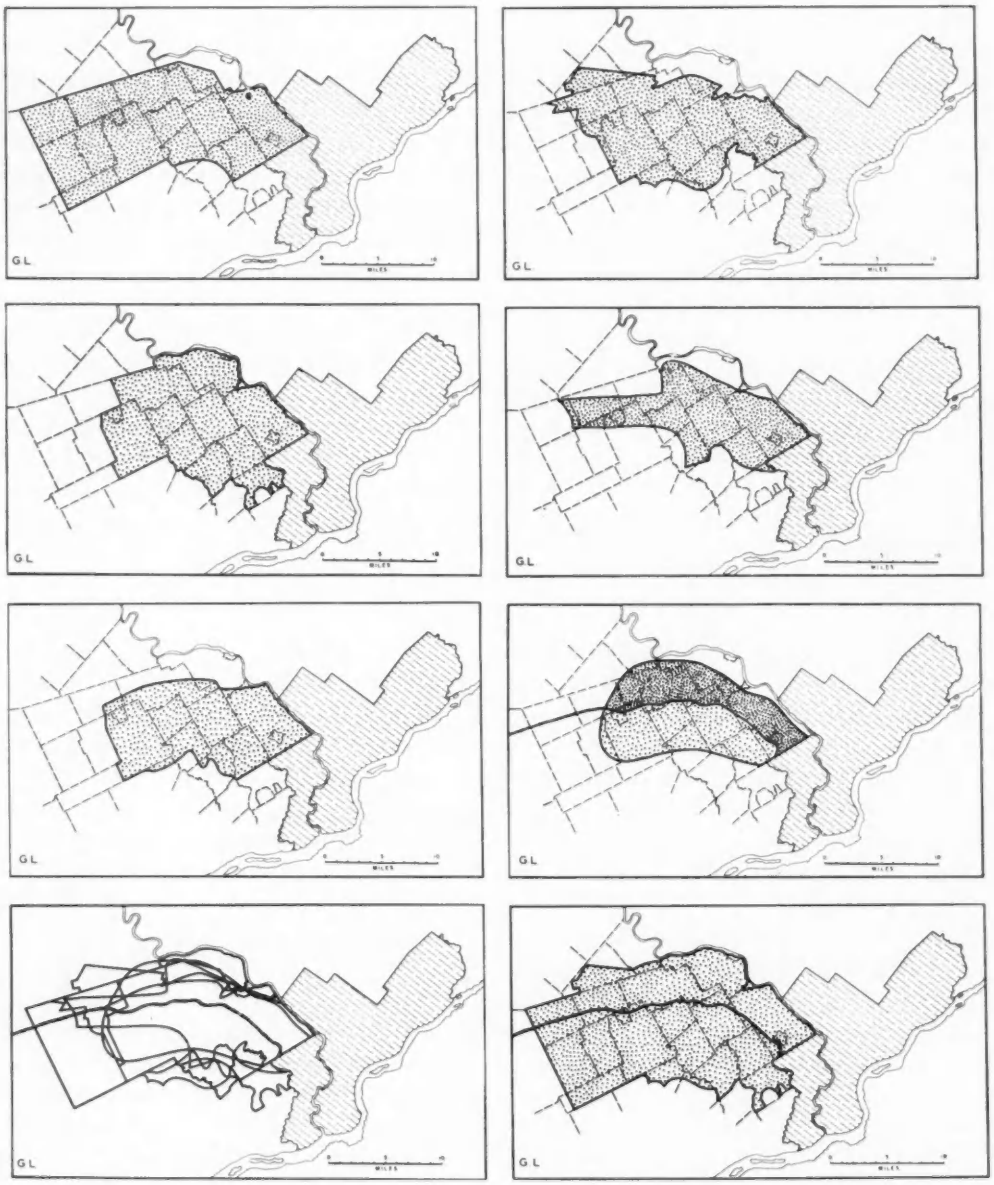

FIG. 4 (upper left). The approximate extent of the original Welsh Tract is shown by the dots superimposed upon the presently existing township structure. The area of diagonal lines represents the city of Philadelphia.

FIG. 5 (upper right). The area covered in soliciting advertisements for listing in the classified section of the Philadelphia Suburban Telephone Directory is shown by dots.

FIG. 6 (second row, left). The territory served by the Main Line Division of the Philadelphia Electric Company.

FIG. 7 (second row, right). The approximate "area considered Main Line" by the Western Division of the Philadelphia Suburban Water Company.

FIG. 8 (third row, left). Approximate extent of the Main Line District as determined from property atlases of real estate firms.

FIG. 9 (third row, right). Extent of the Main Line District based on social factors as described in text. The bisecting line represents the route of the Pennsylvania Railroad.

FIG. 10 (lower left). Extent of the Main Line District as determined by superimposition.

FIG. 11 (lower right). The Main Line District is shown here at its maximum extent as determined from Figure 10.

personal visits. They were asked to express their opinions on such questions as "What do you think are the limits of the Main Line?" "Do you commute to the city regularly?" By comparing such opinions and estimates, the line indicated in Figure 9 was determined. It must be remembered that this limit is based on the opinion of the common man on the street; it does not take into consideration the particular interpretation of those possessing wealth, of those socially prominent, or of those of any one nationality. It represents merely the approximate area covered by people who consider themselves "Mainliners" regardless of who they are or what kind of a house they live in.

This version of what makes the Main Line is one that will not be agreeable to everyone, particularly those who take into consideration on which side of the tracks a person lives. There are those who consider only that area lying to the north and east of the tracks as "Main Line." Surveys of real estate offices appraising value of properties show that east of the railroad track in Lower Merion Township lie the greatest number of large estates and the location of the "choice" Main Line residences. If a person wishes to think in such terms, it is necessary to disregard the other beautiful spacious country places and estates located elsewhere nearby. Nevertheless, there are those who have this concept and firmly believe that unless you live on this side of the track, you are not in the class of "on the Main Line." To them, it is the "correct" and "only" side of the railroad. Perhaps they have a right to believe as they do, but their interpretation is just one of many. The area north and east of the railroad in Figure 9 shows this "choice" area as nearly as could be determined by combining conclusions of a personal on-the-field survey and various viewpoints of individuals and real estate people.[9]

USING SUPERIMPOSITION TO DETERMINE THE EXTENT

The boundaries of the Main Line District as determined by the original Welsh Tract, the transportation system, telephone network, electric utilities, water supply facilities, real estate property atlases, and social factors have been considered. It is now the problem to create a uniform "Main Line" region. Figure 10 represents the limits that were determined by superimposing one map upon the other. It is important to notice how the various boundaries almost coincide and to see how the area lying adjacent to the route of the railroad stands out as the focal point of the region.

By eliminating all the lines except the one extending the extreme limit in any one direction, it was possible to draw the limits of the Main Line as expressed in Figure 11. Without a doubt, Figure 11 covers a greater total area than most people would believe is truly Main Line. It must be remembered that the amount of claim any particular spot has to the title "Main Line" varies throughout the area. Figure 10 illustrates this variation somewhat. Certainly there is little doubt that that portion of the area covered by *all* the limiting maps (represented on Figure 10 as the area enclosed by the lines nearest the railroad) has a more definite claim to the title "on the Main Line" than has that territory farther out covered by one or more, but *not by all*, of the limiting maps.

Notice that the region, as here limited, has an elongated shape; one end seems to rest on the Philadelphia boundary line. Although some people think of the area as crossing the city line into the Over-

[9] The two degrees of dot density on the map are intended to bring out this contrast and do not reflect any contrast in population density.

brook section of western Philadelphia, this hardly seems justified. City Line Avenue, which coincides with the edge of the city, is a strong boundary. The Schuylkill River *seems* to form a definite northern boundary by preventing communities like Manayunk and Conshohocken across the river from making the claim that they are on the Main Line. Yet some of the places on the south side of the river have a doubtful claim to that title; therefore, the river seems to make a rather weak dividing line. In many ways, it even tends to bind together the areas on both sides into an industrial region that could be considered completely separate from the Main Line. Many of the industrial communities, then, on the southern shore of the river are not typically of the "Main Line" type. The western limit, though less definite, happens to practically coincide with the line considered as on the edge of the metropolitan district of Philadelphia as indicated by the United States Bureau of the Census. Probably the most significant factor influencing the location of this western limit is the importance of the community of Paoli, since it marks the western terminus of frequent local commuter trains. There are such trains operating farther west, but the service is not as well adapted to the needs of daily commuters. The boundary line on the south is chiefly determined by convenience, mostly in being able to reach commuter stations along the railroad. As a rule, if it is more convenient to reach the city by some other means of transportation, that locality has little or no claim to the title "Main Line." There is little doubt that at present the location of the railroad is the single largest factor in determining the amount of claim that any particular locality has to the title "Main Line."

It is possible, then, to actually confine this region to definite bounds by utilizing the process of superimposition, and, in so doing, be successful in eliminating much of the confusion that results when a line is not specifically drawn. It is necessary to draw a line somewhere for the sake of clarity, even if it is perhaps better expressed as being transitional.

THE FUTURE MAIN LINE

It is also necessary to state that this region is not a stable one. It is very probable that the extent of the area considered "Main Line" herein will gradually expand. The areas that have great claim for being described as "definitely on the Main Line" will become more extensive, mostly at the expense of the "more doubtful sections" nearer the margins of the area as limited by superimposition. Even the doubtful area should expand to sections not today considered as "Main Line," as improved methods of transportation make it possible to live farther out and still commute to employment in the city. It is logical that this territory would be taken mostly from agricultural country lying to the west. The Schuylkill River and the industrial areas along its valley will prevent much expansion northward. Industry is not characteristic of the Main Line. Even at present, the industrial region to the north closely approaches the Main Line's borders. It is possible to see the smoke and stacks of the factories from advantageous positions in the northern part of the Main Line Region today. Eastward in the environs of the city's limits, little expansion can take place. City-like crowding is not typical of the Main Line. Only to the northwest, west, and southwest is there ample territory for expanding the limits of the Main Line.

Certainly the boundaries of this rather flexible region will be influenced by the route of the new Pennsylvania Turnpike.

The route does not bisect the area, but instead it approaches from the northwest in the vicinity of Valley Forge Park and terminates within the region near the community of King of Prussia. Perhaps the people who inhabit the area along the new "main" route will call themselves "Mainliners" for a considerable distance farther west than is now indicated. It would be most interesting, indeed, to follow up this study in a decade or so to actually determine how elastic the boundaries of this region are and to see what changes occurred.

THE FISHERIES OF NORTHWESTERN NORTH AMERICA

Gordon W. Hewes

Dr. Hewes is Visiting Lecturer in Anthropology at the University of Colorado. His paper is based in part on ethnographic study of Indian fishing in northwestern California, undertaken in connection with work for a doctorate in anthropology.

NORTHWESTERN North America is a major geographic and faunal area, and in some respects an area with a basic cultural unity. The boundaries are somewhat naively given: that part of western North America with a prevalent cold- and clear-water fish fauna, limited on the east and south by arid regions incapable of supporting such a fauna except in the high mountains, and by the Great Plains with its warm and muddy streams. The western boundary is the Pacific Ocean, or better, its bordering waters which were fished in aboriginal times. The southern boundary on the coast is approximately at Monterey Bay, south of which there is a distinctive marine fauna characterized as "semi-tropical." From Monterey Bay as far as Southeastern Alaska is a recognized Northeast Pacific fauna characterized as "semi-arctic." Within the latter area, a northern and southern subdivision can be distinguished, separated by Cape Flattery.[1]

The northern and northeastern limits of the area are determined by the range of a particular genus of fishes, *Oncorhynchus*, the Pacific salmons. This faunal distribution probably reflects geographic controls more subtle than those usually selected to demarcate major geographic regions. The genus *Oncorhynchus* continues west of Bering Strait, and has a wide coastal distribution in Northeastern Asia, but there are cultural and other reasons for separating the Siberian Pacific coast from the American Salmon Area. While the faunistic distinction between Alaska and Siberia is not sharp, and the Bering Strait is not an important biogeographic boundary, there are a few significant differences in the aquatic faunas which belong to the Nearctic and Palaearctic faunal zones, respectively. True loaches (*Cobitidae*) and the barbels (*Barbus* spp.) are not found in Alaska, while the family of suckers (*Catastomidae*), well represented in Alaska, has only a few Asiatic species.

Biological Features

The facts which we have chosen to set off this area from the rest of the continent are basically climatic, since the major biological distinction is between species which inhabit cold, generally clear waters, as against those which prefer warm and often murky waters. Cold water has a much greater capacity to support fish and other aquatic animals, simply because cold water has a greater capacity to absorb dissolved oxygen. Water under the same pressure can hold almost twice as much oxygen at a temperature slightly above freezing than at 86° F. Hence, a cold body of water has nearly twice

[1] David Starr Jordan and C. H. Gilbert: "List of the Fishes of the Pacific Coast of the United States, with a Table Showing the Distribution of Species," *U. S. National Museum Proceedings*, 1880, Vol. 3, pp. 452–458.

as much "breathing space" as a warm body of water of the same volume. This also explains in part the greater productivity of swift, shallow streams as against deep, quiet lakes; not only can light penetrate to the bottom of a shallow stream, where the photosynthesizing plant organisms are concentrated, but dissolved oxygen is much more abundant close to the surface, especially where it is broken by rocks and riffles.[2]

The unifying biological factor within the area we have delimited is the occurrence in both fresh and salt water of great numbers of Pacific salmon species. This common element in otherwise diverse aquatic environments, from

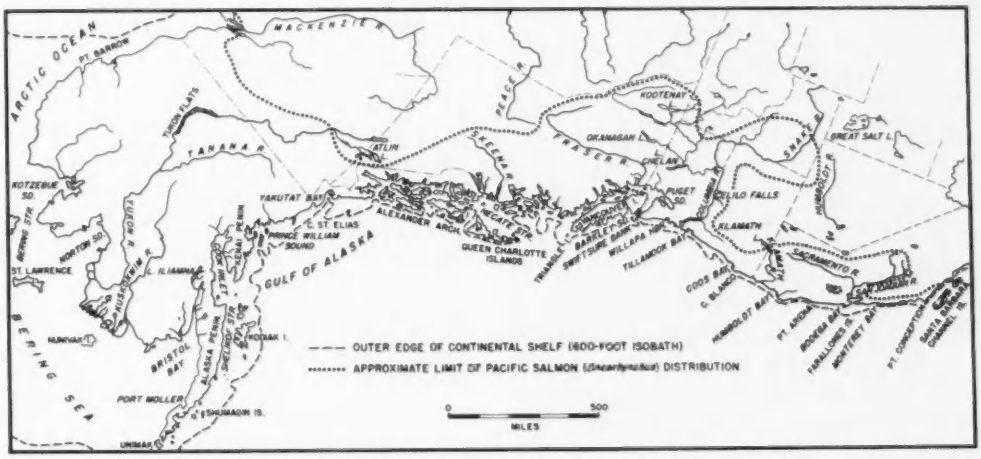

FIG. 1. Northwestern North America Fisheries Area.

northern Alaska to Central California, and from the outer edge of the Continental Shelf to the headwaters of streams on the Pacific slope of the Rocky Mountains, fails only in a few areas which are inaccessible to migrating salmon because of waterfalls or extensive marshes. The most important of these salmon-less enclaves in the area are the Clear Lake Basin, the Klamath Lake basin, and possibly parts of the Willamette Valley. The Snake River valley above the falls is outside the Salmon Area rather than a salmon-less pocket within it. The five species of Pacific salmon die after a single spawning migration into fresh water from the ocean, a fact which distinguishes them from other important anadromous species.

A zoogeographical region depends upon an ensemble of species, and the Salmon Area is perhaps too large and diverse to be considered as a biotic unit. The distributions of marine species, other than as mentioned in discussing the boundaries, above, show no particular conformity to the salmon range. The distributions of other species, such as halibut, herring, cod, blackfish, grayling, or whitefish, would be insufficient in themselves to serve for the characterization of the area. An attempt to map the approximate distributions of all the important species in the aboriginal fishery has indicated to the writer the insurmountable difficulty which would be encountered in treating the fisheries of the area as a unit without the presence of Pacific salmon as the common feature.

[2] Paul R. Needham: "Trout Streams; Conditions that Determine Their Productivity and Suggestions for Stream and Lake Management," Ithaca, 1938, p. 56.

CULTURAL UNITY

The basic cultural unity of the Salmon Area is best expressed in its material phases. It is well to deal separately with the primitive and modern cultures which occupy the area, even though there are certain significant carry-overs from one to the other.

Aboriginal Cultural Unity of the Area

The area was bound together by the intensive use of fishery resources. Clark Wissler described and mapped the Salmon Area as one of the major subsistence regions of aboriginal North America. In his well-known culture area classification for the continent, he listed dependence on salmon or on sea foods as first among the traits characterizing the Plateau, North Pacific Coast, and Eskimo areas.[3] While much of the territory has a heavy soft wood forest cover, and use of these woods was a characteristic feature of the technology of many of the primitive groups, fishing was a more basic integrating factor. Many of the cultural similarities of the area were negative traits, and as such perhaps less valuable for the purposes of classification. Agriculture, domesticated animals other than the dog, pottery (generally speaking), elaborated political organization, stone architecture, and other absences, do not serve to distinguish the cultures of the Salmon Area from regions farther east or south, such as the northern interior of Canada, the Plains, and California outside the salmon range. On the other hand there are cultural continuities, some of them indicating an ultimate connection with Northeastern Asia, others of Northwest Coast or Plateau provenience, which prevail over most if not all of the area. They certainly adhere rather consistently to the climax zone of the Salmon Area, which follows the coast with few interruptions from the southern Bering Sea to the mouth of the Klamath River.

In a world-wide study of statistical correlations of various subsistence patterns, Simmons found a very low degree of specificity of association of societal traits among groups which he classified as "fishing tribes."[4] Hunting, herding and farmings groups seem to have more distinctive social features. It may be that the apparent neutrality of fishing in relation to social organization is due to the rarity of clear-cut cases of exclusive dependence upon this means of subsistence outside of the New World. Almost everywhere else, save in Northeast Asia, fishing is combined with hunting, herding, or farming, or is carried on only by small segments of larger societies. Within the Salmon Area, patterns of social organization, like language groupings, conform rather poorly to its other features.

Some of the important elements in the culture of the Salmon Area are wholly littoral in their distribution, such as those relating to sea mammals and marine mollusks. In general, the cultural linkages are most numerous near the coast, and diminish rapidly as the inland boundary of the area is approached. This does not mean that the diffusions of fishing traits were all coastwise, or from the same center. If the history of fishing in native North America is ever reconstructed, it will almost certainly exhibit a diversity of origins.

Modern Cultural Unity of the Area

The new culture which succeeded the aboriginal cultures of the area in the

[3] Clark Wissler: "The American Indian: An Introduction to the Anthropology of the New World," 3rd ed., New York 1938, Chap. 14.

[4] Leo W. Simmons: "Statistical Correlations in the Science of Society," *in* G. P. Murdock (ed.), "Studies in the Science of Society presented to Albert Galloway Keller," New Haven, 1937, pp. 495–517.

19th and early 20th centuries was essentially homogeneous. Despite the difference in nationality, Alaska, British Columbia, and the states of the northwestern United States form a continuous zone of Anglo-American pioneer settlement. The outposts of Russian and Spanish culture, important in the initial exploration and white settlement of the area, were practically obliterated by the masses of English-speaking people who entered mainly after 1850. The unifying economic factors have been the fur trade, fishing, mining, and the lumber industry. The cross-cultural link with the pre-existent aboriginal economic pattern is the exploitation of the fishery resources, the subject of this study.

The economic development of the area in all of its subdivisions from the time of first white exploration has been characterized by a remarkable adherence to a single pattern. To be sure, the economic historian Innis, in comparing the Canadian and United States frontier developments, stresses the differences rather than the underlying similarity.[5] The fur trade was the first commercial pattern to be imposed on the subsistence activities of the natives. In this the Russians were the pioneers, but their activities were confined to Alaska and to sea otter hunting along the coasts to the south, as far as Lower California. The Anglo-Canadian fur trade expansion was partly overland, partly maritime. American enterprise in the fur trade, as distinct from British interests, began shortly after the Revolution. The maritime phase of the fur trade involved fur seals and sea otters, while the overland trade was concentrated on the beaver. The fur trade began to decline some time before the emergence of gold mining as the dominant activity. California, the northwestern states, British Columbia, Alaska, and the Yukon Territory, all passed through turbulent gold rushes, and, when these subsided, they entered a recent era in which fishing and lumber became the major interests, with agriculture and commerce based on transcontinental railroads gradually overcoming the predominance of these extractive industries.[6]

While the sequence of furs, gold, fish, and lumber holds true for most of the area, the durations of the various phases in different regions have been unequal. In Alaska, fishing and the fur trade persisted until the end of the 19th century, when gold and other mining suddenly became important. In California and British Columbia, mining preceded the significant commercial development of the fisheries, though only by a few years. Gold mining has never been especially important in Washington, and Alaskan timber is largely unexploited even at the present time, but these and other deviations do not seem serious enough to invalidate the generalization stated. Siberia's economic development has followed a roughly parallel sequence, but the area is much larger, and its history lacks the categorical neatness which typifies the Anglo-American Salmon Area frontier.[7]

The development of commercial fishing within the area may be divided into stages which are applicable throughout. Craig and Hacker make out three stages or phases: (1) Indian fishing, for food; (2) Intermediate, barter by whites for fish from Indians, and whites engaging

[5] H. A. Innis: "The Fur-Trade in Canada; an Introduction to Canadian Economic History, 1497–1783," New Haven, 1930.

[6] C. S. Kingston: Chapter 2 in Otis W. Freeman and Howard H. Martin (eds.), "The Pacific Northwest; A Regional, Human, and Economic Survey of Resources and Development," New York, 1943.

[7] Theodore C. Weiler: "The Fur Trade Frontier of Siberia," *in* G. P. Murdock (ed.), "Studies in the Science of Society . . . ," New Haven, 1937, pp. 519–536.

in some fishing and salting, etc. of their own; (3) Intensive exploitation, beginning with canning.[8] The first of these phases belongs to the pre-white period, and we shall designate it as the native subsistence fishery. The third period can be called the commercial fishery. Intensity of exploitation was high in both the native subsistence fishery and in the modern period, and since Indians and Orientals performed most of the labor in the commercial fishery, at least in its earlier stages, it seems inappropriate to call it the "white fishery."

HYDROGRAPHIC AND BIOLOGICAL BACKGROUND

Some of the geographic or hydrographic features of the area have been mentioned above. Relatively heavy dependable rainfall, low summer temperatures, at least along the coast, and various terrain factors produce cool- and cold-water streams and lakes throughout the area. Because of a well developed vegetational cover, run-off is slower, and streams are generally freer of silt than in the Great Basin or Plains. Rugged mountain ranges, some of them close to the sea, provide the maximum number of cold, mountain streams with gravel beds suitable for the spawning of Pacific salmon species.

Too much emphasis on the hydrographic unity of the area is misleading, however. Prior to their spawning, and during their upstream migrations, these salmon are able to adapt themselves to rather widely differing aquatic environments. Thus, there is little similarity in the main courses of such rivers as the Sacramento, the Snake, the Quinault, the Karluk, and the Yukon, yet these all have important runs of salmon. The Sacramento flows through a plain bordered by oak and willow groves, issuing eventually into a broad tule marsh delta. The Snake, after passing through an arid sagebrush plain, enters a long and tortuous gorge. The Quinault rises in a mountain mass in a district characterized by extremely heavy rainfall, and its course takes it through a lake in a basin clothed with a dense spruce and hemlock rain forest. The Karluk is a short stream on an exposed island, Kodiak, while the Yukon, fifth largest river in North America, after a 2000-mile course through a broad and wooded valley, debouches on an extensive tundra delta, interspersed with sphagnum bogs.

The formation of winter ice is significant in the annual fishing pattern of the modern as well as of the aboriginal fisheries of the area. The ice which forms along the coasts in the northernmost part of the area has a well-known relation to sea-mammal hunting. The restricted movements of seals in ice-bound waters make their capture far easier than in the open waters of summer. Fishing, on the other hand, is seriously hampered by ice, and dwindles in importance during the winter months. Weyer notes the delicate balance of ice-covered and ice-free water required for the most productive sea-mammal hunting.[9] Though certain species of seals can scratch breathing holes for themselves through thin ice, most sea-mammals must migrate to ice-free areas in winter, or at least to sections where there are always leads or openings. Continuous, thick sea-ice obviously excludes all lung-breathers from beneath it. Too much open water reduces the localization of hunting sites, and increases the tasks of the hunter, who must then pursue his quarry rather

[8] Joseph A. Craig and R. L. Hacker: "The History and Development of the Fisheries of the Columbia River," *U. S. Bureau of Fisheries*, Bull. 32, 1940, p. 139.

[9] Edward Moffat Weyer, Jr.: "The Eskimos, Their Environment and Folkways," New Haven, 1932, pp. 111–112.

than simply wait for it beside a breathing hole, as in the method called *maupok*. Important ice-hunting for sea-mammals did not extend much farther south than the Yukon delta; at Nunivak it was negligible.

At one extreme of the Salmon Area, in northern Alaska, fishing is practically limited to a few months in summer and autumn before the freeze-up. At the other, along the shores of Washington, in western Oregon, and in California, it is a year-round activity, with a summer peak of intensity. Ice is formed in mountain streams in winter throughout the area, and significant though not thick ice is accumulated on all the rivers beyond the immediate coastal zone from Oregon northward. The Columbia River generally has some ice as far down as the Dalles, and on one occasion it was frozen over near the mouth of the Willamette and filled the river with floes down to its mouth.[10] In spring, melting snow and ice give rise to freshets, a phenomenon of great importance in the inland fisheries cycle. The unpredictable variation in water level even on the large rivers during the season of the thaw means that many kinds of fishing gear cannot be used. In particular, weirs, dams, and traps, are likely at such times to be completely washed out by the floodwaters. Even where there is no winter snow accumulation, high water from heavy winter rain, as in parts of California, has much the same effect, so that year-round installation of weirs, etc., is impracticable. Only in regions with a virtually changeless hydrographic regime would permanent construction of such devices be possible under conditions of aboriginal technology. Some of the traps used in the modern commercial fishery are of course capable of withstanding winter ice and spring floods.

Variability of stream flow within the salmon area is fairly great, though by no means as pronounced as it is in the intermittent streams of the Great Basin or the rivers of the Plains. Maximum variability is characteristic of the Snake tributaries and of the streams of the western slope of the Sierras. The mortality of fish and other aquatic life in such watercourses is typically high. The destructive effects of flooding on fishery resources were pointed out many years ago by George Marsh.[11] Spring floods, even in the coastal districts of British Columbia and in western Oregon, may expose or bury gravel beds suitable for spawning, undercut banks, and, at river mouths, break or shift sand bars, radically altering the fishing landscape. Landslides may have even more drastic effects; the great rock slide in Hell Gate Canyon, near Yale, B. C., brought about, to be sure, by railway construction rather than natural causes, greatly reduced the Fraser River red salmon spawning in 1913.[12]

The coastal indentations from central California to Cape Flattery are mostly submerged river mouths, the most outstanding being that of the Columbia Estuary which extends for 140 miles. The estuaries of the Chehalis, Willapa, Umpqua, and Coquille are from 25 to 30 miles long. With few exceptions these inlets are heavily silted, with barrier beaches and sand spits. The latter are unstable landscape elements, and their destruction or movement by stormy seas can affect the salinity and other factors of the estuary waters, with possible changes in fauna. Thus,

[10] H. H. Bancroft: "History of Oregon," *Works*, Vol. 30, Part 2, San Francisco, 1888, p. 40.

[11] George P. Marsh: "The Earth as Modified by Human Actions; A Last Revision of 'Man and Nature'," New York, 1885, p. 108.

[12] George A. Rounsefell and George B. Kelez: "The Salmon and Salmon Fisheries of Swiftsure Bank, Puget Sound, and the Fraser River," *U. S. Bureau of Fisheries*, Bull. 27, 1938, p. 776

the cutting of the Tillamook sand spit in 1939 was a serious threat to the oyster industry in the bay.

On the seacoast, tidal variation is a significant determinant of certain biological conditions. Some mollusks, such as oysters, are adapted to brackish water which must be constantly mixed by the tides. The bays of Oregon, the outer coast of Washington, and some areas of Puget Sound like Hood Canal are especially suited for the natural production of mollusks. The California coast is less favorable, except in San Francisco, Bodega, and Humboldt Bays. Clams were abundant in the fjorded coastal regions of British Columbia and southern Alaska; on the exposed coasts, mussels were more common. Tidal variability is utilized for a simple native fish-trapping device, which is nothing more than an open basin of rocks in which fish are stranded at low tide. Such traps were made around Vancouver Island especially, but compared to other methods trapping was not important. Among the less obvious effects of tidal changes is that connected with ice-fishing in winter. On Nunivak Island, Lantis noticed that tomcod could be taken effectively only when high tide was approaching.[13] Where the tidal interval is sufficiently large, the living space available to certain sedentary mollusks and crustaceans is increased vertically. Whether this was sufficient to produce any locally significant mollusk fishery in aboriginal times is not known.

Sea fishing in the area prior to the coming of the whites did not extend to the more distant portions of the offshore banks, which, while smaller, can be compared to the bank fisheries of northwestern Europe or the Newfoundland-New England area. There was significant use of the bottom-dwelling species on the outer banks only on the Northwest Coast and in the vicinity of the inhabited islands off southern and southwestern Alaska. Elsewhere the continental shelf, i.e., the submerged seaward extension of the continental land mass which averages less than 100 fathoms in depth, is too narrow for the development of important ground-fish resources. Off California, the shelf is less than a mile or two in width at some points. Thus, while albacore were undoubtedly taken in great numbers by the aboriginal fishermen of the Santa Barbara Channel, they were not sought north of that region until long after the establishment of the commercial fisheries. Not until 1936 were albacore caught off the coasts of Oregon and British Columbia, and then they were found to occur only at considerable distances from shore.[14] The slight use of the offshore fisheries in aboriginal times in the area is partly explained by the fact that already adequate supplies of fish could be taken with much greater ease from rivers and streams. A second, but perhaps less important reason was entirely cultural: the lack of seaworthy canoes over much of the southern portion of the area. It is noteworthy that in the only section south of Cape Flattery with an extensive and productive continental shelf, the mainland coast and Channel Island region of Southern California, seaworthy canoes were apparently independently developed.[15]

Isolated offshore rocks and islets are particularly suited to be the breeding places of certain sea-mammals and seabirds, safe from the depredations of

[13] Margaret Lantis: "The Social Culture of the Nunivak Eskimo," *Transactions of the American Philosophical Society*, Vol. 35, Part 3, 1946, p. 171.

[14] U. S. Secretary of the Interior: "Fishery Resources of the United States," 79th Cong., 1st Sess., S. Doc. 51, 1945, p. 41.

[15] Robert F. Heizer: "The Frameless Plank Canoe of the California Coast," *Primitive Man*, Vol. 13, 1940, pp. 80–89.

land animals. Where these refuges were accessible, native hunters took advantage of them. Others, like the Pribilofs, may not have been visited until post-white times. Many of these pinniped resorts are rocks only a few hundred yards offshore; others may be in sea caves at the base of cliffs. Besides the Pribilofs, which are the summer habitations of the fur seal herds, major sites of this kind include Bogoslof, about 35 miles west of Unalaska, Triangle Island off Vancouver Island, Tillamook Head, Point Arena, Point Reyes, the Farallones, and Point Año Nuevo. Aside from these, there were many lesser sites frequented by fur seals and sea lions. Where the hunters had no seaworthy boats, they might swim to rocks close to shore in order to harpoon or club sea-mammals.

A few species have been introduced to Pacific coastal and river waters since 1870. The most successful exotic is the shad, now one of the most abundant food fishes in Pacific coast rivers, particularly in the Sacramento and in the Lower Columbia. Introduced mollusks have also been quite successful, and in some cases have entirely superseded the native species.

The accompanying map shows the inland and seaward boundaries of the area from a fisheries standpoint, and the locations of its major river systems, bays, estuaries, offshore rocks, islands, and the outer limit of the continental shelf.

SUMMARY

Northwestern North America, from the standpoint of its aboriginal and commercial use of fisheries resources, is that part of the continent with a cold- and clear-water fish fauna, limited east and south by arid regions, and by the Great Plains, and on the northeast by Arctic drainage streams which lack the Genus *Oncorhynchus* (Pacific Salmon). This genus is the unifying biological factor, at least in a cultural and economic sense, if not biogeographically. Aboriginally the area was outstanding for its intensive use of fishery resources, inland and coastal, with salmon in the interior, and sea-mammals and marine mollusks on the coasts as the leading products. In the 19th and 20th centuries the area was settled by white people, carrying a generally similar culture (Anglo-American). Throughout the area, the sequence of economic development has usually been: fur trading, fishing, gold mining, and the lumber industry. Of all of these extractive industries, fishing has survived most successfully.

OPEN FIELD FARMING IN THE YAKIMA VALLEY, WASHINGTON

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THE Yakima Valley of Washington enjoys a national reputation as a fruit producing area, a distinction that has been earned through quality production, national advertising, and national as well as international marketing. As a result teachers, textbooks, and articles dealing with the valley emphasize the importance of fruit. It is not generally realized that this area has become a significant producer of open field crops and several specialties, and has a noteworthy animal and poultry industry. Together these phases of farming now bring an income to Yakima Valley farmers equal to that of fruit.

Indicative of the growing importance of open field farming are the following changes in the rank of the Yakima County portion of the valley among the counties of the nation between 1940 and 1945: (1) in grape production it rose from thirty-first to twenty-first place; (2) in sweet corn, from ninety-eighth to twenty-sixth; and (3) in vegetables from eighty-fourth to forty-first position. Other open field crops have followed this trend. The number of animals on farms has also risen. Yakima County in 1945 ranked fifty-seventh in cattle and calves whereas in 1940 it was not among the first hundred. Sheep and turkey production has increased as well.

Several factors combined to account for these increases: (1) During the past decade the Roza Project has been completed adding 72,000 acres to the irrigated land of the valley. Much of this new land is not suitable for fruit growing. (2) Removal of many of the high cost apple orchards in the Lower Valley during the 1930's made available land for open field crops. (3) Decreases in acreage planted to several low income crops, such as alfalfa and grains, and a shift to higher income crops also have been important. For example, Yakima County declined from fifth place in alfalfa production in 1940 to tenth in 1945.

The purpose of this paper is to describe and analyze open field farming and the animal industries of the Yakima Valley, thereby completing a study of Yakima Valley agriculture which was begun by the authors with "The Fruit Industry of the Yakima Valley, Washington" in Volume 25 of ECONOMIC GEOGRAPHY.

PHYSICAL SETTING OF THE VALLEY

The drainage basin of the Yakima River, extending diagonally through Kittitas, Yakima, and Benton Counties in South Central Washington, contains an area of 5970 square miles (Fig. 1). The term "Yakima Valley" is commonly applied to the 500,000 acres comprising the irrigated portion of the basin which lies in Yakima and Benton

Counties. The valley of the Yakima River is not a single basin, but a series of basins separated by anticlinal folds of the underlying basaltic lava. Where the river cuts through these anticlines there are narrow water gaps; elsewhere the valley is broad and undulating. The more northern of the basins in Kittitas County, known as the Kittitas Valley, has its own economy. It is separated from the Yakima Valley by an anticlinorium 30 miles wide through which the Yakima River has cut a gorge 500 feet deep and, therefore, it will not be included in this study. Five miles south

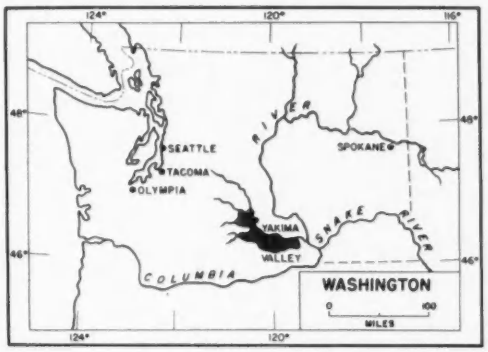


FIG. 1. Regional setting of the Yakima Valley.

of the City of Yakima, the Yakima River passes between Ahtanum Ridge and Rattlesnake Hills at Union Gap (Fig. 2) and enters the Lower Valley, the largest area of level land in the state. North of this gap (Union Gap) the valleys are collectively known as the Upper Valley and contain a larger amount of hilly land.

The arid climate of the Yakima Valley is favorable to the growth of many middle latitude crops when irrigation water is supplied. Although it is essentially continental in character, the moderating effects of the Pacific Ocean are not entirely cut off by the Cascade Mountains. The Northern Rockies are effective barriers, blocking off many of the Polar Continental air masses which pass along their eastern margin. Winters are generally moderate with only occasional sub-zero temperatures. The mean January temperature at Yakima is 28° F. and at Wapato, in the Lower Valley, 29° F. Freezing weather with varying warm periods may be expected from September through March. Summers are warm and dry with an average July temperature of 71° F. at Yakima and 74° F. at Wapato. An average daily maximum of 100° is common throughout the valley. Rapid radiation aided by mountain breezes causes the nights to be cool, giving a diurnal range of 30 to 40 degrees. The growing season of the valley averages 190 days. Lower lands are more subject to late spring frost and, therefore, are more commonly planted in annual and late blooming crops.

The bolson-like character of the Columbia Plateau, of which the valley is a part, precludes heavy precipitation. Because the prevailing west winds that cross the valley are descending, they are drying, and as a result the annual precipitation at Yakima is only 8 inches and at Wapato, 7.6 inches. Nearly 70 per cent of the precipitation falls between October 1 and April 1. Irrigation water stored in mountain reservoirs for summer distribution supplements this to provide sufficient moisture for plant growth (Fig. 3).

In the valleys of the Yakima and its tributaries, the lava is deeply buried under sandstones, shales, glacial lake sediments, and alluvium. The predominant soil of the Yakima Valley is a fine textured volcanic ash of considerable depth, frequently underlain with gravel from decomposed basalt. There are also alluvial loams, silt and sandy loams, and wind laid deposits commonly found on the west slopes. Smaller areas of shallow soil underlain with coarse river gravels are occasionally

found. In the low lying lands accumulation of soluble salts and alkali occurred during the later stages in the development of present land forms and drainage patterns. Nearly every district has some alkali and saline soils. In some cases improperly controlled irrigation has led to an increase in alkali lands; in other instances land which was formerly strongly alkaline has been washed so free of salts that it is useful for cropping. Sugar beets and asparagus are successfully grown on alkali soils as they are more tolerant of this condition than other crops.

OPEN FIELD FARMING

Open field farming is most general in the Lower Valley where the area in fruit is restricted by a limited amount of suitable slope land with good air drainage. There are many field crops grown but only a few are to be found on an individual farm. Some farmers have used a rotation scheme based on: (1) a cultivated row crop, (2) alfalfa, and (3) small grains. In addition, many farmers have a part of their acreage planted to perennial specialty crops such as grapes, asparagus, peppermint, or hops. The majority of the farms range from 20 to 100 acres in size, for it has proved unprofitable to practice general farming on less than 20 acres. The larger farms, averaging 80 acres, are generally on the Indian Reservation (Wapato Project) on the west side of the river in the Lower Valley. This condition is the result of the policy of alloting 80 acres to each Indian family. Some white farmers rent two or more Indian farms. In contrast to the high frequency of owner operation in fruit farming, tenancy is rather high on open field farms because: (1) open field farming requires small capital investment, and (2) many Indian owners prefer to rent their farms rather than do their own farming.

Row Crops

The most common cultivated row crops include potatoes, sugar beets, corn, asparagus, and several other com-

FIG. 2. Looking south through Union Gap. Two railroads and two main highways pass through this narrow water gap made and occupied by the Yakima River.

mercial vegetables (onions, carrots, tomatoes and melons). Potatoes, sugar beets, and corn are frequently included in a rotation system and substituted for each other according to the farmer's preference based upon his appraisal of disease and pest risks, the machinery he has available, the adaptability of his land, and prices.

With the addition of the irrigated land of the Roza Irrigation Project (Fig. 3), which was started in 1935 and completed in 1948, the Yakima Valley has superceded the Kittitas Valley as the largest potato growing area in the state, and increased from sixtieth to thirty-seventh position among the counties of the nation between 1940 and 1945. Potatoes are well distributed throughout the Roza Project, the Indian Reservation, and the Sunnyside Valley. The plantings have varied from 8000 to 13,000 acres between 1942 and 1948 (Table I) increasing toward the latter date due to high prices, government buying of surplus production, and increased available land in the Roza Project.

Both early and late potatoes are grown. Occasionally, a crop of each

TABLE I

SUMMARY TABLE OF ACREAGE, PRODUCTION, AND TOTAL VALUE OF THE MAJOR OPEN FIELD CROPS OF THE YAKIMA VALLEY[1]

(Compiled from United States Reclamation Bureau Annual Reports and the Indian Service Reports of the Wapato Project)

	Project Divisions				
	Sunnyside[2]	*Roza*	*Wapato*[2]	*Tieton and*[2] *Upper Val.*	*Totals*
HAY AND FORAGE CROPS					
Acreage	53,670	15,260	50,600	3,970	123,500
$ Value	2,689,000	780,000	2,556,000	135,000	6,160,000
SUGAR BEETS					
Acreage	3,220	300	12,090	50	15,660
Production (tons)	61,820	5,290	253,730	1,060	321,900
$ Value	680,000	58,000	3,628,000	12,000	4,378,000
POTATOES					
Acreage	490	6,610	5,570	60	12,730
Production (bushels)	154,440	2,857,900	2,305,600	13,900	5,331,840
$ Value	170,000	4,001,000	2,386,600	19,000	6,576,000
HOPS					
Acreage	3,270	530	3,430	100	7,330
Production (lbs.)	6,793,790	839,940	6,066,000	118,810	13,818,540
$ Value	4,620,000	571,000	3,943,000	81,000	9,215,000
CEREALS					
Acreage	9,580	3,520	22,400	420	35,920
Production (bushels)	512,940	104,880	1,606,400	17,410	2,241,630
$ Value	942,000	184,000	1,468,000	29,000	2,623,000
VEGETABLES					
Acreage	2,050	4,010	4,950	80	11,090
$ Value	452,000	738,000	1,111,000	26,000	2,327,000
ASPARAGUS					
Acreage	4,840	260	700	.....	5,800
Production (lbs.)	13,601,800	439,000	2,686,000	.....	16,726,800
$ Value	1,020,000	33,000	210,000	.....	1,263,000
TOTALS					
Acreage	77,120	30,490	99,740	4,680	212,030
$ Value	10,573,000	6,365,000	15,302,600	302,000	32,542,600

[1] Acreage and production to the nearest tens; value to the nearest thousand dollars.

[2] Acreage, production, and value of crops in the Sunnyside and Wapato divisions are slightly less and in the Tieton and Upper Valley are considerably less than actual amounts, because figures are not available from the private irrigation projects, of which there are several.

may be grown in the same field during the same season, the late crop being planted after the early potatoes have been harvested. Heavy fertilization is required for this practice. Early varieties include White Rose, Bliss Triumph, and Irish Cobbler (according to the farmer's preference) while the late potatoes are always Russet (Netted Gem) which are suitable for storage.

Yields vary from four to 24 tons per acre depending on condition of the soil, care received, amount of fertilizer used, and seasonal conditions. Except for irrigation (Fig. 4), all the necessary work from the planting (March 1 to July 1) through the harvest (July 1 to November 1) is done by machinery. A recent labor saving development for harvest is the sacking attachment used with a tractor-drawn mechanical digger and operated by a crew of six or seven men. This is half the number required for conventional hand gathering. The sacking attachment is not adaptable to stony soil, but most growers who have few rocks on their land are now using this machine.

Early potatoes do not keep well because of the heat during the harvest season and the fact that in the rush to secure high prices farmers do not wait for the potatoes to mature. Therefore, they are shipped to market immediately after harvest. On the other hand, late potatoes are often stored in underground cellars to be sold during the winter months as the demand increases. Most farms which produce potatoes have a cellar capable of storing between 300 and 3000 tons. Many of the early varieties are shipped to North Pacific Coast markets while the late potatoes may go to more distant points.

Since the development of a blight resistant strain, sugar beets are high on the list of cash crops grown in the Lower Valley with a pre-war average annual planting of 10,000 acres. As a result of war stimulus and continued high prices, this was increased to 15,660 acres in 1947. The long, warm growing season, a plentiful supply of water, and the deep, fertile soils are favorable to beet growing. These factors make the yield per acre in the Yakima Valley one of the highest in the United States. The greatest concentration of plantings are on the Indian Reservation where plots of open land are available. However, some beets are grown throughout the Lower Valley.

Sugar beets are grown from seeds which are planted about the middle of

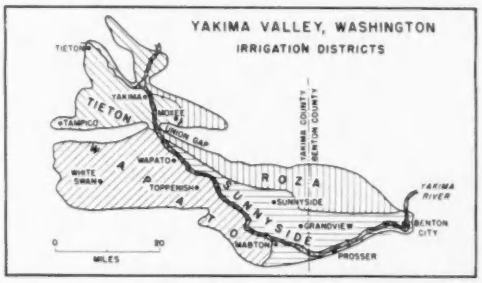


FIG. 3. Several irrigation districts characterize the Yakima Valley.

April. A few weeks after the young plants are up they must be thinned (blocked) to allow for the expanding growth of the roots, and during the summer the fields must be kept free of weeds. Blocking, which is a hand operation, is becoming less necessary since a method has been developed for breaking the clusters of seeds apart before planting. Harvest normally begins late in September and continues until about the middle of November. The beets are lifted and topped in the field, then hauled by truck to Toppenish or to the nearest railway receiving station. Here they are either loaded into freight cars for delivery to the factory or placed in storage piles for subsequent movement. The lifting, topping, and loading are now done mechanically on

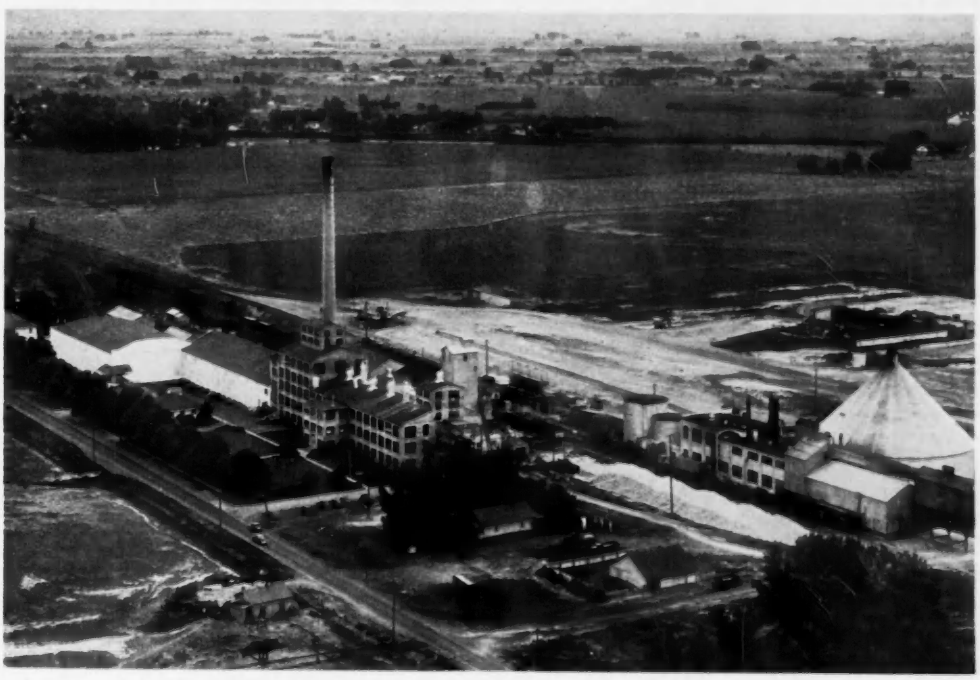


FIG. 4. Irrigating a field of late potatoes on the Roza Project. Note concrete pipe in the foreground—a common method of distributing water without waste in the Lower Valley. (Photograph by courtesy of Yakima Chamber of Commerce.)

FIG. 5. U and I Sugar Refining Company at Toppenish. (Photograph by courtesy of Yakima Chamber of Commerce.)

many farms. The majority of farmers still use hand labor, mainly Mexican, but the trend is toward mechanization as improved machinery becomes available.

All of the beets grown in the valley are processed at the Utah–Idaho Sugar Company Plant at Toppenish (Fig. 5). The slicing capacity of the plant is about 2000 tons of beets every 24 hours.

Corn is the least important of the cultivated row crops but, with the increase in livestock and dairying, the acreage has steadily expanded, in a large measure at the expense of wheat and rye. The major portion of field corn is grown on the diversified farms of the Lower Valley where the major use is for ensilage for winter feed with only a small part of the crop allowed to mature to be fed as grain. Income from field corn is rather low compared with cash crops, and since it is closely related to animal production will fluctuate with it.

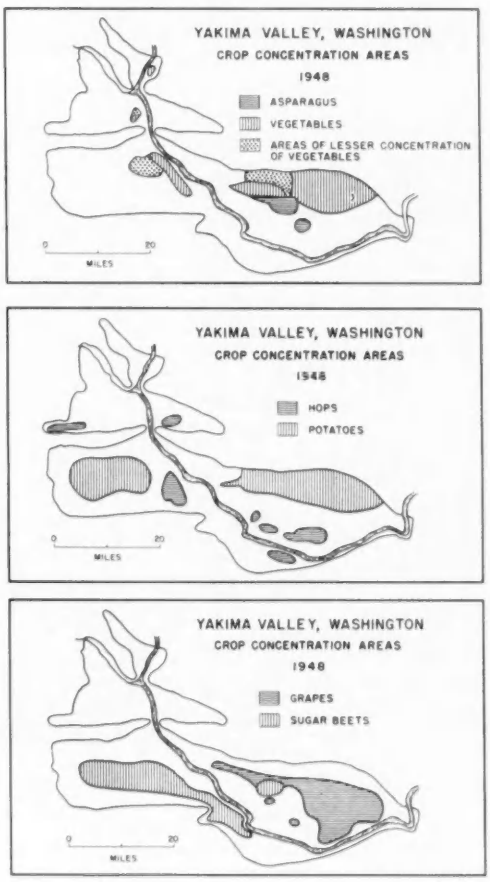
Sweet corn, grown throughout the valley, tends to be concentrated around Sunnyside and Toppenish because of marketing possibilities. A cannery in Toppenish has been taking most of the crop, but now freezing companies in several towns are also processing corn. Because of this additional market the sweet corn acreage may continue to increase. There were about 2000 acres in Benton County in 1946 and 1947 and between 9000 and 10,000 acres in Yakima County.

Other Commercial Vegetables

Commercial vegetable production contributes a significant segment to Yakima Valley farm income, bringing in annually about $2,500,000 (exclusive of potatoes and asparagus). Favorable soil conditions, early springs, the long, dry growing season, and irrigation water make possible a wide range of products and insure high yields and quality. Some vegetable acreage is found throughout the valley, but the greater portion is concentrated on the Indian Reservation and in the lower half of Yakima County (Figs. 6–8).

Most produce is grown by operators whose units are rather large, ranging from 40 to 100 acres. Large scale operation is possible since much of the work can be done mechanically; few vegetables are grown which require large amounts of hand labor. The labor requirements, supplied largely by Mexicans, are kept at a minimum by planting at intervals throughout the season.

Acreage devoted to the several vegetable crops varies greatly from year to year depending upon individual grow-



FIGS. 6–8

er's estimates of market possibilities. In 1948 there were 1284 acres of onions, 800 acres of cantaloupes, and 500 acres of watermelons. Tomato acreage was somewhat lower than normal with 1500 acres.

Renewed activity is being shown in dry bean production. About 500 acres were grown in 1947. The acreage jumped to 3500 in 1948 and 5000 acres were produced in 1949. Virus curly top, or Western Yellow Blight, heretofore had reduced yields to the point that bean growing was not profitable. The development of resistant varieties has overcome this difficulty and an average production of 2500 pounds per acre places the Yakima Valley among the highest bean producing areas of the United States. Beans are grown primarily on the newly developed Roza Project and in the Wapato-Toppenish area of the Reservation. The Davis-Baxter Company in Grandview has a large plant and is expanding its facilities to clean, polish, and handle dry beans. It now has a storage capacity of 15,000,000 pounds of dry beans.

Corn, carrots, and peas are grown mainly on contracts. Such organizations as California Packing Corporation; Libby, McNeil, and Libby; Birdseye; Snyder; Santa Cruz; and General Foods are located in the valley and process these crops. Onions, melons, and tomatoes are marketed through Pacific Fruit and Produce Company, the Phillipino Produce Company, and local produce firms. Local truckers also haul large amounts of fresh produce to markets in the Puget Sound Lowlands and to Portland.

Forage and Grain Crops

Alfalfa planting was developed simultaneously with the first irrigation development and alfalfa was the leading crop for some time, but the acreage has been gradually decreasing during the past 20 years owing to low income per acre as compared with other crops. It is still the most extensively grown crop on the Indian Reservation, occupying about 30 per cent of the total irrigated land in that area. Three cuttings of alfalfa are commonly made each year with a total yield of about three to five tons per acre. Nearly 60,000 acres are cut each year. Most of the crop has been trucked to Seattle and Portland for sale, but an increasing amount is being fed to dairy and beef cattle in the valley.

Other kinds of hay such as clover and timothy are of minor importance because they are less palatable to cattle. The Indian Reservation has the majority of the horses; therefore, timothy is more common here although there are only about 700 acres in the entire valley.

There has been a gradual decrease in the acreage planted to small grains because larger returns can be realized from other crops. Fields of small grains are scattered throughout the Lower Valley, often being included in a rotation scheme and seldom occupying the same land two years in succession. Because of this lack of concentration no attempt has been made to map them. Wheat was formerly the leading grain but it has been replaced by oats and barley which are better cattle feeds. Very little grain is sold outside the valley although considerable quantities of baled straw are trucked to the Puget Sound Lowland for use as bedding and litter in dairies and poultry houses.

Specialty Crops

During the past ten years grapes, asparagus, hops, and peppermint have become firmly established as important cash crops in the Yakima Valley. Environmental conditions are such that optimum production is obtained in each

of these perennial crops. The major concentrations are in the Lower Valley where suitable flat land is available and higher summer temperatures favor high yields.

Grapes have been grown in commercial quantities for more than 20 years, but maximum development has occurred since 1940. Between 1940 and 1945 Benton County rose from forty-sixth to twenty-seventh position among the grape producing counties of the nation and Yakima County rose from thirty-first to twenty-first place. Experts believe that within the next decade the valley will become the leading American producing district of Concord grapes. Grapes grown in the Yakima Valley have a sugar content four or five per cent higher than those of the Great Lakes states. Production per acre is higher, eight tons per acre being average in the Yakima Valley with some yards yielding as much as 15 tons per acre. The major concentration of vineyards is south of Union Gap, particularly in the area from Zillah to Prosser with newer plantings on the adjacent Roza Project (Fig. 8). The future of the grape industry is in the production of American varieties including (in order of importance) Concords, Campbell's Early, Wardens, and Moore's Early.

Since grapes do not blossom as early as most tree fruits, there is less danger of damage from late spring frosts. The care given vineyards is similar to that given orchards. Each winter the vines are pruned back to within about two feet of the ground. In the spring the new vines are trained to grow on trellis wires and during the summer they are cultivated and irrigated. Picking begins the middle of September and continues through October.

A number of plants for processing the grapes have been built in the past ten years. These establishments, located at Sunnyside, Grandview, and Prosser, produce juice, jam, and jelly. Only a small percentage of the crop is shipped directly to market to be sold as fresh grapes.

Several vineyards in the Sunnyside-Grandview district grow European varieties although the climate of this area is not considered as suitable as in California. These varieties are used entirely for wine making, and the Washington Liquor Board protects the vintners by limiting the amount of wine imported into the state. The vineyards growing European types are largely controlled by the Upland Winery in Sunnyside and the National Winery in Grandview, whereas the majority of yards producing grapes for juice are individually owned.

On the broad plain of the Lower Valley surrounding Sunnyside the asparagus acreage increased from 168 acres in 1924 to 7100 acres in 1945. Seventy-five per cent of this increase occurred after 1936.

Asparagus is somewhat tolerant of alkali, producing well on soils which will not grow other crops and which would otherwise be lying barren. It is also well suited to the family type of farming; on fields of five to ten acres the average family is able to do all the necessary work including cutting. Because it matures early in the spring and the harvest season is long, it tends to spread the farmer's labor and income over a longer period. Beginning about 1940 several large canning companies bought land and are raising asparagus. In addition, a number of growers have gone into the industry on a large scale. Several farms contain over 200 acres of asparagus, but the average is from five to ten acres.

The cost of establishing asparagus fields is relatively high compared to most other field crops because three years must elapse before new plantings come into production. With proper

care and fertilization a field may be profitably cut for many seasons; several in the Sunnyside area have been producing for over 20 years. Yields of four tons per acre are not uncommon and the average gross income per acre in recent years has been about $500.

Asparagus is the first crop to mature in spring with cutting beginning about the middle of April and continuing through June. Fields must be harvested every day during the season and all stalks over six inches high are cut. Individual stalks may grow six inches in 24 hours. Local laborers, consisting of large numbers of teen age students, cut the major portion of the crop, but because of the expansions some large farms must be cut by transient labor. The working day starts at daylight and ends about noon. Payment for cutting has averaged 85 cents per hour during the past five years.

During the early part of the season the bulk of the crop is sold on the fresh market. Growers pack their asparagus in 30 pound crates which are shipped all over the country in refrigerated trucks and railroad cars. When the price of the fresh product drops too low, growers sell to the canneries and freezing plants which process at least 70 per cent of the crop. Because of its market possibilities and adaptation to poorer soils, asparagus will undoubtedly remain an important crop in the Lower Valley.

The acreage of hops in the Yakima Valley increased 205 per cent in the period from 1940 to 1945. This was due largely to the excellent soil and climatic conditions for this crop and to the wartime destruction of the European fields which had formerly exported hops to the United States. Among the crops grown in the valley, hops rank second only to fruit in per acre income; in recent years several yards have yielded $1,000 per acre. The total value of the valley's hop harvest is exceeded only by that of apples. The greatest concentration of hop yards is to be found in four areas: around Moxee City, the Tampico district, the Indian Reservation-Mabton district, and the Sunnyside-Prosser area (Fig. 7). The first has the greatest number of yards, but the latter two have the greatest acreages and contain the bulk of the recent plantings.

Although the cost of harvesting hops formerly made up 46 per cent of the cost of production, machine picking has largely replaced the Indians, Mexicans, Orientals, and Caucasians who performed this service. Ten men with a machine now do the work which formerly would have required 200 laborers. Many of the hops are grown by farmers who have been producing for a number of years. Much of the increase has been in the size of their fields, or new fields have been planted by descendants of these experienced farmers. Some of the plantings have been made by brewing companies who hire foremen and laborers to care for their yards.

The hop vine is perennial, grows 15 or 20 feet tall, and is supported on trellis wires. The vine is grown for its cones (hops) which impart the characteristic flavor to malt beverages. One-half pound of dried hops is added to each 31 gallon barrel of beer made in the United States. Ninety-eight per cent of the hops are marketed for this purpose.

The 1947 production of 14,000,000 pounds of dried hops in the Yakima Valley in addition to Oregon and California production has somewhat oversupplied the market with the result that plantings have decreased since that date. The wartime price of 75 cents per pound has been cut to 55 cents partly because of the surplus and partly because the European hop yards are again producing. The import duty on European

hops has also been cut from 24 to 12 cents per pound against the protests of the Washington Hop Growers' Association. A more complete discussion of the hop industry can be found in an article by the authors, "The Hop Industry of the Pacific Coast," which appeared in the February, 1950, issue of the *Journal of Geography*.

Peppermint might well be termed a wartime crop since important production in the Yakima Valley began as a result of increased need of peppermint oil for medicine during the last war. Demand and prices increased so rapidly that, after trials assured the crop would produce well, plantings were made as fast as roots were available. Recently, however, the rate of planting has decreased.

Cultivation of the crop consists of planting the roots in shallow trenches and keeping the field free of weeds. Since quality of the distilled oil depends to a large extent upon the freedom of the field from weeds, it is a common practice among the better farmers to clean the fields by hand at least once in late July or early August. The plant is perennial and produces profitably for fifteen or twenty years with little attention except irrigation and weeding. The leaves and stems of the plant are mowed by machine (Fig. 9) in early September. The crop is usually raked with a common hay rake although some farmers use wind-rowing implements attached to the mower. After partial curing, the mint hay is hauled to the "still" where it is packed into a large, covered tank. Steam is passed through it distilling the oil which is drained from the surface of the water and stored in iron barrels. The stills are commonly heated by fuel oil. Many growers with large acreages own stills, but it is more common for two or three growers to own one jointly, and some still owners do custom work. The residue from the still is usually fed to livestock.

The area of greatest production is in the southern part of the Lower Valley near Sunnyside, where 1300 acres were grown in 1948, and about 300 acres were grown in other parts of the valley. The yield varies from ten to 100 pounds of oil per acre and the price has fluctuated from three to 12 dollars per pound since 1940. The price in 1948 was $6.50 per pound with an average yield of 50 pounds per acre. Even at the lowest price, average per acre returns from peppermint are considerably greater than from alfalfa. Production costs are approximately equal since alfalfa fields are mowed three times per season. Moreover, the yield of an alfalfa planting decreases after four or five years.

Because of small labor requirements and complete mechanization, peppermint fits well into a general farming scheme. The future looks relatively bright since the average yield of 50 pounds in the Yakima Valley far exceeds the 30 pound average for the other major peppermint areas in Michigan and Indiana.

Animal Production

Production of animals within the valley began with the influx of the first settlers in the 1880's and has continued to the present. However, the number of animals produced has been small until the past decade. The rearing of cattle and sheep is well adapted to a diversified farming program, and their production has been stimulated by an added demand for meat and milk. Population has increased in the Yakima Valley, in the towns where atomic energy was developed, and in the rapidly growing cities of the Pacific Northwest. The increase in the number of farms and more intensive farming have made

a larger demand for animal fertilizer. Orchardists have paid up to 20 dollars a ton for manure in the past decade.

Many bands of sheep are grazed in the Cascade Mountains during the summer months and wintered in the valley. The moderately cold, dry winters are conducive to the rearing of sheep. The warm, dry months of spring make open range lambing possible and alleviate the necessity of barns or sheds to protect the young lambs born during the month of March. During late May the bands of sheep are driven to the mountains or may be shipped by railroad as far as Montana to Rocky Mountain pastures. By July or August the lambs are fat, weighing about 90 pounds, and are shipped by truck directly to Seattle and Portland or by rail to Chicago. In autumn the band is driven or hauled back to the valley where adequate amounts of hay and grain for feed and large amounts of pasture are available. The waste left in the sugar beet fields (tops, weeds, and small beets) is excellent feed and is commonly bought for that purpose. Most of the stubblefields remaining after the grain has been harvested furnish pasture. Frequently, farmers prefer to sell the last cutting of hay for pasture rather than have the expense and difficulty of mowing and curing it during the months of heavy dew, fog, and lower temperatures.

Sheep are scattered throughout the valley during the autumn months but the greatest concentration is in the Lower Valley in the Wapato, Toppenish, and Sunnyside areas. Few are to be found in the orchard areas of the Upper Valley and on the irrigated lands of the Roza Project. The arsenate of lead used for insect control makes grazing in orchards dangerous. In the newly developed Roza Project there are less weeds and consequently there is less feed for sheep.

Dairy cattle are scattered in small herds on the open field farms. A few large dairies are located near the cities of Yakima and Sunnyside, but most of the cattle are in herds of five to 15 cows on diversified farms. Many of the towns have creameries and some cream is shipped to Ellensburg and Seattle for processing. More commonly, the whole milk is shipped to market daily, thus requiring a minimum of equipment on the farm. Large amounts of whole milk are processed at the evaporated milk plant of the Morning Milk Company at Sunnyside.

Few beef cattle are bred in the valley except for a scattering of purebred stock. Small numbers of feeder cattle are brought in during the autumn for fattening purposes. At that time there are a number of waste products which can be purchased at low cost. These include cull potatoes, beet tops, pulp from the sugar beet factory, sweet corn husks, etc. These supplement the alfalfa hay and grain, thus fattening the cattle economically. Most of the herds are small as the farmers do not have the yards and feed to care for large numbers. Some are owned by the farmers and some are fattened on contract for the meat packing companies in Yakima and Sunnyside. One herd of about 1000 head is kept by a hop grower, principally for the fertilizer obtained.

Marketable size flocks of turkeys have been raised in the Yakima Valley since 1926, but the large commercial expansion has occurred since 1940 (Fig. 10). Recent production has been about 250,000 birds annually. The valley has several advantages for raising turkeys: (1) green feed can be grown all summer, (2) no shelters except shade are required in this dry climate, (3) the dry soil deters the spread of diseases, and (4) turkey raising is well suited to a

FIG. 9. Mowing and windrowing peppermint hay in the Lower Valley. The men are shocking while the hay is green to prevent loss of leaves. The small shocks are easier to load. (Photograph by courtesy of The Bureau of Reclamation.)

FIG. 10. Flock of turkeys in the Lower Yakima Valley. Open sheds in the background are for shade. (Photograph by courtesy of Yakima Chamber of Commerce.)

diversified farming program on open field farms.

Most turkeys are raised in the area between Toppenish and Prosser on diversified farms. There are few strictly turkey farms. The average flock is about 2000 birds, that being the number that one man can handle easily. Commercial turkey raising requires at least 40 acres of land since the birds must be moved so that they do not occupy the same area more than once in three years; by this means diseases are more easily controlled. Those farms raising alfalfa are well suited to turkey production, since after the third or fourth year when the yields decline the field can be used for turkey pasture. Sunflowers are also planted for both shade and feed. During the summer the birds eat the lower leaves and in autumn the stalks are bent down so they can consume the mature seeds thus supplementing the corn used for fattening.

Many growers keep breeding stock and raise their own poults by use of large incubators. The poults must be kept in brooder houses for eight weeks after which they are strong enough to be turned out in pasture. The birds require seven months to reach maturity, during which time each one consumes about 60 pounds of prepared mash and 40 pounds of grain in addition to green pasture. The killing season extends from the latter part of September to January. Over one-half of the meat is sold through the Washington Co-operative Farmers' Association.

SUMMARY AND CONCLUSIONS

The Yakima Valley is an important area for the production of open field and specialty crops as well as fruit. Many of the factors that favor the fruit industry are also conducive to general farming. These include suitable soil, favorable climate, available water for irrigation, nearness of the valley to the cities of the Pacific Coast for marketing purposes, and an available labor supply. Moreover, the two farming enterprises are non-competitive for land because flat land which is excellent for open field or specialty crops is not suited to orchard crops and vice versa.

With additions in acreage planned for the next 20 years, total production of the valley will increase. New skills in farming and the development of varieties of crops and breeds of animals better suited to local conditions will also bring greater results. Increased mechanization will lower the operating costs. Adequate processing plants to handle many of the food crops are being built, and it appears that improvements are being made in marketing conditions. Owing to the great distance between the valley and the larger market cities of the East, it seems probable that an increasing amount of concentration and processing of products will be carried on in the valley in the future, thereby encouraging an increasing growth in urban centers.

BOOK REVIEWS

Geography in the Twentieth Century. Edited by Griffith Taylor, with chapters by 20 authors. x and 630 pp.; maps, diagrams, glossary of terms, index. Philosophical Library, New York, and Methuen, London, 1951. $8.75. 5¾ by 8¾ inches.

This new work dealing with the field of geography is quite diverse in content and interest. Its authors come mostly from the English-speaking world: seven are from the United States, six are Canadian, five are English, and two are Slavs. There are three major parts. The first deals with the evolution of geographic thought and its philosophical basis. This part includes an excellent summary of 19th century geography by Tatham, and other chapters on the history of geographic thought in Europe and America. There is an introductory chapter by Griffith Taylor, in which the concepts of environmental determinism are championed, and a concluding chapter by Tatham in which environmentalism and possibilism are presented.

The second part deals with environment as a factor. At least that is the heading given to this second part; but the chapters range widely in content and in philosophical approach. To this reviewer the outstanding chapter of this section, and of the whole volume, is one by Karl J. Pelzer entitled "Geography and the Tropics." Pelzer takes a broad view of the problem of tropical settlement and of the role of the low latitude regions in the modern world. The movement of middle latitude peoples into the various parts of the tropical world is outlined. In providing an adequate supply of labor for the production of those things desired by the European and American nations, commercial agriculture has been developed by the plantation system and by the system of peasant farmers. The advantages and disadvantages of these two systems are compared. Two kinds of settlement are also described and analyzed—shifting settlement and permanent settlement. Then the question of European and American occupance of the low latitude regions is discussed. Seven pages are devoted to a survey of tropical diseases and their significance in limiting the areas suitable for settlement, or in reducing the productivity of areas already settled. Pelzer concludes his chapter by pointing out that those persons who think of the low latitudes as offering even a partial solution to the ills of the European world by offering new raw materials, or offering markets for manufactured goods, or areas for new colonization are doomed to disappointment. He suggests some of the things that need to be studied and some of the major problems that stand in the way of raising the economic contribution of these regions. The chapter offers an excellent picture of the whole broad problem of tropical development, a picture which avoids the common nonsense about the incredible fertility of tropical soils and the depressing effect of tropical heat and humidity, and which focuses attention on the real problems to be faced.

Part three is entitled "Special Fields of Geography." And here again the content and interest are varied. D. F. Putnam starts out with a chapter dealing with "Geography is a Practical Subject." He should not credit the students at a summer school with the quip "Geography is what geographers do," for this was actually first published in the presidential address (of the Association of American Geographers) of A. E. Parkins and was originated by Wellington D. Jones. He proceeds to offer a necessarily sketchy view of field and laboratory techniques, which is much too large a subject for the space provided. Watson's chapter on the Sociological Aspects of Geography attempts to define the content and approach of that elusive thing called "Social Geography." Griffith Taylor's "Geopolitics and Geopacifics" (accent on the a) concludes the volume, returning again to the theme of environmental determinism.

PRESTON E. JAMES

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Introduction to Geography, by HENRY M. KENDALL, ROBERT M. GLENDINNING and CLIFFORD H. MACFADDEN. xii and 752 pp.; color plates, maps, diagr., ills., appendices, index of geogr. terms, index. Harcourt, Brace and Company, New York, 1951. $6.25. 10 x 7½ inches.

This review is written on Mt. Oread in Lawrence, Kansas. The narrow crest of this mountain, graced by the University campus, lies about 200 feet above bordering flood plains and precipitous slopes border it on three sides. But according to the text here reviewed, we are not seated on a mountain; not even a hill: "Hilly country is, in a loose sense, a baby edition of mountain country. Altitude is appreciable (500 feet is an absolute minimum), and local relief is marked, but usually less than 2,000 feet, though more than 500 feet" (p. 185). And so

we Kansans are deprived of both mountains and hills. We wouldn't even pass the course if we traded Mt. Oread for "mole hill" because what kind of a mole would it take to build hills 500 feet high? Nor is our loss assuaged by "the whirling fury of a Kansas tornado" (p. 76).

We recommend this text for careful examination and consideration by all who teach a beginning course in college geography. The approach is systematic rather than regional, and most of the pages are packed with basic terms, definitions, and some illustrations (written and pictorial). In fact, at times the pack is rather solid and we tried to recall the definition of a glossary. A beginning course covering the entire school year can perhaps serve the entire book; a one-semester course will have to skim and skip. The text material is rather "lean meat"—all muscle—and so accompanying lectures should perhaps add some fat and spice for flavor. However, this is easier said than done if much or most of the text is going to be covered well.

Time was when a systematic text in the field paid its respects to weather elements, climate, landforms, and for good measure added a chapter on ground water and perhaps one on minerals. Subsequently material was added on soils and vegetation and a chapter or two would take care of "the cultural landscape." The present text expands the "cultural landscape" into ten chapters (Part Three: Elements of the Cultural Setting) under such headings as "World Population," "Settlement Types and Contrasts," "Determinants of Settlement Pattern," "Manufacturing Regions," "Agriculture and Animal Husbandry," "Mining and Mining Regions," "Utilization of Forests," "The World's Fisheries," and "The World Pattern of Routes." Important, these? Of course. But this expansion raises a number of problems. New terms are pyramided higher and higher (many of them dealing with elements) with a minimum of explanation, elaboration, and application. Little space is left to relate these concepts to a map or a functional world. Is this making the best use of the students' time in a day when many have apparently never heard of Czechoslovakia and would consider it a major achievement to find it on a map? Moreover, when mature college students expect to pass through Georgia and Mississippi on the most direct route between Minneapolis and Seattle (see N. Y. *Times*, June 11, 1951), are they ready for a bundle of *elements* or should their noses be rubbed into a bundle of maps so that ordinary important geographic features become oriented in their minds? Perhaps the beginning course should not be an "all-in-one" course on elements. Among other things, once they have learned that a hill must be over 500 feet high, something should be added about the geographic significance of hills.

Many features of this text rate high. Certain chapters are almost masterpieces of clear and concise writing. Examples are Chapters 1, 2, 3, 5, 6, and a good many others. Well-selected, well-phrased questions follow each chapter. Good pictures and diagrams abound in the text, although a few pictures will puzzle the reader looking for "the point" or "a point." Most of the maps are well conceived and reproduced. Again, there are exceptions, such as Figure 77 (p. 112) "Mean Annual Precipitation." Almost everything is wrong with this map and the average student will not even be able to find the outline of the continents.

Chapters 7 and 8 on climatic types are based on the Köppen system, which is set forth in detail in Appendix B. These chapters are really packed with terms, symbols, and temperature and precipitation data. Although it is pointed out that the symbols may be ignored, the beginning student will still find these chapters a jungle of words and figures. Reading and teaching will have to proceed slowly or the result will be confusion and frustration. Moreover, in these and other chapters the student is hardly impressed with the significance of the details he may have learned with much effort because of limited application. Some users of the text will want to rearrange the sequence of chapters in a teaching program. The chapters on the classification of climates are followed by several chapters on landforms. Material usually closely associated with climatic types, such as vegetation, soils, agriculture, and forests, is discussed in Chapters 14, 15, 24, and 26.

Standard climatic charts and "wheel" charts are introduced on pages 55 and 56. The latter type is adapted for use in the chapters covering climates apparently because, "On this type of chart the year does not begin suddenly out of nowhere' nor does it end suddenly at a chart margin" (p. 56). However, what is gained by circular continuity is lost by significant but "lesser" deviations from month to month, particularly with regard to temperature data. Deviations from a straight line are more readily detected and measured than deviations from a true circle. We prefer our old climatic charts.

The color map showing the "Climatic Types" (Plate V) also raises some problems. In the United States, the Humid Subtropical type (Cfa) reaches from the Gulf to the southern border of Lake Erie. What is subtropical about the winters in Ohio and central Illinois? To the student this type becomes almost meaningless when this large area is lumped into one type—particularly when he has so many other vexing details to struggle with. Better color differentiation would also help this map. The reader will have difficulty—I find it impossible—to distinguish between the red showing Tropical Rainforest (Af) and the red showing Humid continental with hot summers (Dfa-Dwa).

In an otherwise good chapter on "Settle-

ment Types and Contrasts" (21) no mention is made of line settlements, conspicous in southern Louisiana, southeastern Canada (both French), and certain parts of Europe. At least some sociologists recommend agricultural line settlements because they combine the advantages of dispersed settlements with those of nucleated or village settlements.

Question 2 on p. 22 asks, "What is the only source of energy in the solar system?" Since this question follows a treatment of the solar system, "old Sol" is clearly indicated. Now we also have atomic power—at least to sear and shatter things—and what about the tides and the pull of gravity (setting temperature conditions aside)?

In conclusion I must again return to the hills. Aside from making a casualty of all Kansas hills —not to mention our mountains—the text also obliterates the Newer Appalachian "Mountains" and shrinks the Older Appalachians. The caption for Figure 161 reads, "The Hilly lands of eastern North American constitute a barrier between the east coast and the interior. The St. Lawrence and Hudson-Mohawk routes are the only lowland corridors through the hilly barrier" (p. 229). In other words, we now have to tell our students that the barriers our sturdy, intrepid forefathers had such difficulty in negotiating were the "hills" of eastern North America and that easy passes around the "hills" had to be sought in the above-mentioned lowlands (and perhaps the Cumberland Gap). So speaks the text.

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The Geographic Regions of Puerto Rico, by RAFAEL PICÓ. xiii and 256 pp.; maps, ills., diagrs., bibliogr. University of Puerto Rico Press, Río Piedras, P.R., 1950. 9¼ x 6 inches.

No person could write with more authority on the geographic regions of Puerto Rico than Rafael Picó. He has been President of the Puerto Rican Planning Board since its inception in 1942, he was elected President of the American Society of Planning Officials in 1949, and again in 1950, and he has already made significant contributions to various aspects of geography. *The Geographic Regions of Puerto Rico* is based on the author's Ph.D. dissertation (Clark University, 1938), but the material "has undergone numerous changes in order to bring it up to date."

Eleven regions have been delimited on the island of Puerto Rico, largely on the basis of such physical factors as topography, soils, and climate. However, historical factors are not neglected, and the economic and social climate is studied as assiduously as the physical climate.

The big problem of Puerto Rico is to minimize the pressure of a rapidly increasing population on the agricultural resources of the island. From 1899 to 1939 sugar acreage increased sevenfold while acreage in food crops increased only 2⅙ times. The challenge is being met by increasing the per-acre yields of land, by fostering industries which will tend to absorb some of the surplus rural population, and by encouraging migration to areas where the migrants will be well received. Governments everywhere are increasingly being held responsible for certain social and economic services to the electorate, and the insular government has not lagged behind; it has taken the initiative in many phases of the economic life of the island.

Attacks on the problems of the island are typified by the La Plata project, a rural rehabilitation unit of the Mennonite Church of North America in the "Humid East Central Mountains." Here "some of the evils of the agricultural set-up" in the island "Land concentration, absentee ownership, and excessive, unjustified crop specialization are being dealt another heavy blow" (p. 172). . . . "The present program consists of four phases of rural service, medical, recreational and educational, agricultural and religious." This is only one of many important projects. The Insular Department of Agriculture is just about to complete a detailed Land Use Survey of the entire island. Dr. Picó played a leading role in pushing this survey from the project to the action level.

This is a balanced study. The author skillfully presents economic and social factors in historical perspective against the physical background of Puerto Rico in the evolution of the present cultural landscape of the island.

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Uncle Sam's Acres, by MARION CLAWSON. xvi and 414 pp.; maps, diagrs., index. Dodd, Mead & Co., New York, 1951. $5.00. 8½ x 5½ inches.

The Federal Government owns about a fifth of all the land within the borders of continental United States.

For some time there has been need of a book dealing rather comprehensively with these Public Lands. Marion Clawson, Director of the Bureau of Land Management (which administers the second largest chunk of Public Lands), has produced such a book under the title *Uncle Sam's Acres*.

He begins with a few general remarks about the Public Lands and then treats consecutively their acquisition, disposal and reservation—that is, withdrawals for National Forests, Taylor Grazing Lands, Mineral Lands, National Monuments, National Parks, etc. He then discusses the more recent acquisitions of land by purchase and barter, the former being much the most

important. This is followed by two chapters on "What Our Public Lands Are Like" and "We Develop Our Water Resources." Nearly the last half of the book is devoted to the administration and use of our public lands and the politics and policies associated with this administration and use.

Almost everything in the volume is available elsewhere, often in greater detail and often more clearly and authoritatively treated. But this very fact constitutes the greatest strength of the book. On the subject of land acquisition and disposal Benjamin Hibbard's *History of the Public Land Policy* is much more exhaustive, thorough, and scholarly, but for the purposes of most students it is longer and more detailed than necessary. Moreover, much has happened since Hibbard's book appeared. Various treatises deal with the administrative agencies of our public lands much more thoroughly and completely than does Clawson, but once again they are more detailed than the average student needs.

While it is probably accurate to predict that the greatest continuing use of the volume will be for student reading in connection with land questions, it hardly would be fair to the author to imply that the book is merely a useful compendium from published sources. Dr. Clawson is that rare type of administrator who has the ability to look at the general problems of policy, politics, organization, and administration from a somewhat detached and scholarly viewpoint, however little his day-to-day administrative responsibilities allow him to adopt such a viewpoint. While it is true that it would be possible to write the substance of the last half of his book from an examination of sources, nevertheless, it would require the examination of a great many sources and, moreover, it would not be possible to reproduce the relative emphasis, the approach, the passing comments and observations, and the insights which Dr. Clawson provides. These all stem from his years of research pertaining to various aspects of Public Land use and from his recent experience as an administrator. Finally, the latter part of the book contains many of the personal views of Dr. Clawson on various subjects; and, in view of his background, they are worthy of study by even an expert in the field of land management.

Certain other observations seem in order. The volume is completely without documentation. Elaborate documentation may detract from the readability of a book, but occasional citations certainly would not discourage most of the potential readers of the book and would have added to the utility of the study. Occasionally, presumably to make the phraseology more striking or colorful, the author has produced statements that are at best ambiguous and sometimes slightly misleading. These are the exceptions, though, in a volume which is elsewhere distinguished by clarity and ease of expression.

The weakest section of the book is the middle division dealing with the physical characteristics of our Public Lands and the administration of water resources. The latter chapter probably could have been entirely deleted to the benefit of the volume. In the chapter on the physical characteristics of our Public Lands the author seems to be acutely uncomfortable in attempting to describe within the compass of a relatively few pages the physical characteristics of these enormous and diverse areas.

Perhaps the reviewer's opinion is best summarized by saying that he read the volume with pleasure and profit, and immediately recommended to all his major students that they also would do well to study the volume carefully.

WESLEY CALEF

University of Chicago

World Economic Geography, by GEORGE T. RENNER, LOYAL DURAND, JR., C. LANGDON WHITE, and WELDON B. GIBSON. x and 758 pages; maps, ills., diagrs., tables, index. Thomas Y. Crowell Company, New York, 1951. $6.00. 10 x 7 inches.

World Economic Geography is divided into four major divisions. Part One, a short section of 39 pages, in the words of the authors "sets forth the geographical premises underlying the analysis of the major industries" in three chapters, "Man and His Business World," "People, Resources, and Production," and "Principles Governing Production from Land." In Part Two, 294 pages, "the geographical bases for the production of raw materials from farm, range, forest and fishery" are presented to the reader by an examination of commodity production in ten world climatic regions: "The Rainy Tropics," "The Monsoon Tropics," "The Semiarid and Arid Tropics," "The Humid Subtropics," "The Mediterranean and Dry Subtropics," "The Temperate Marine Realm," "The Humid Continental Long Summer Realm," "The Humid Continental Medium and Short Summer Realms," "The Dry Continental Realm," and "The Subpolar Tundras and the Polar Icecaps." In the last portion of Part Two, the authors present a study of forest and ocean resources with chapter headings of "The World's Forests," "The World's Fisheries" and "The Resources of the Ocean."

The longest section of the book, Part Three, 293 pages, includes fifteen chapters under the major heading of "Minerals and Manufacturing." Here "each industry is handled as a unit, beginning with the most basic—power and mineral raw materials—and proceeding to those that use power to fabricate raw materials into consumer goods."

The topic of "Transportation and Commerce" forms the heading for Part Four, 101 pages; and chapter headings include "The Geographical Division of Labor," "Principles Governing the

Exchange of Commodities," "The Trade Center and Its Work," "Landways and Waterways," "Railways," "Seaways," "Airways," and "Man-Made Factors and Controls in Trade."

As might be expected in a text made up of contributions from several authors, the reader will note differences in style and approach. Such differences may distract him slightly. For example one finds a section filled with many references to geonomics together with geographic descriptions summarized by short italicized geographic principles; these are followed by many pages of geonomic writing in a simpler style; then once more the style and approach changes to include descriptions of nutritive-conjunctive-symbiosis and disjunctive symbiosis, and similar complexities. But these complexities are not a serious handicap.

In numbering the many good illustrations, the authors use the chapter number rather than the page number as the major reference key. For example in chapter 33 the illustrations will be numbered 33.1, 33.2, 33.3, etc. Most photographs carry the message desired, but some readers would prefer a smaller number of larger photographs rather than the large number of small photos. Many useful maps are found throughout the text, with no shortage of those showing the economic geography of the United States and its parts. A clearer picture of world distribution of commodities might have been achieved with the addition of a few more world maps.

A major contribution of the book is the emphasis on the part labor plays in the field of economic geography; in fact there is far more than average emphasis on factors outside those of the physical environment. This is not meant to indicate that factors of the physical environment are neglected. In fact a proper balance of emphasis between physical and so-called man-made factors should make the book attractive both to students majoring in the field of economics and those majoring in the field of geography.

New and up-to-date items have been added to the basic materials of economic geography and are presented in an easily teachable form, especially in Part Three. The chapters on "Metal-Fabricating Industries," and "The Textile and Garment Industries" are two of several examples which could be cited.

Leading questions for each chapter follow the descriptive material. These should help both student and teacher who also receive additional aid from the many footnote references included. Some teachers would have welcomed a carefully selected reference list after each chapter.

The text contains 758 pages besides x pages of introductory material. By using two columns on the page opportunity is given for a much more voluminous treatment of the subject than with only one column. The double columns are not crowded, however, and the publishers have used a quality of printing and paper both of which are conducive to easy reading.

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World Railways, 1950–51. Compiled and edited by HENRY SAMPSON. First edition. xii and 596 pp.; maps, diagrams, illus., index. Sampson, Low, Marston & Co., Ltd., London, 1951. £3/3/0. 13 x 8½ inches.

There has long been a need for a standard reference volume giving details of the railways of the world, including such physical characteristics as routes, mileages, gauges, gradients, clearances, dimensions and characteristics of equipment, and traffic volumes. The present volume is the first attempt to meet this need in a comprehensive fashion. It is intended as a reference book, to appeal to a wide variety of needs, including those of engineers, equipment manufacturers, railway enthusiasts, and many others. Geographers will find considerable material of interest in the volume, although, from their point of view, it leaves much to be desired.

The book is a large one, with the same format as that of *Jane's Fighting Ships* and the earlier editions of Talbot-Booth's *Merchant Ships* as well as *Jane's All the World's Aircraft.* It is a worthy companion to those volumes, and should take its place alongside them as a standard reference source in its field. The publishers state in their foreword that it is intended to bring out new editions from time to time in order to keep abreast of new developments in the railway field. It is hoped that this will be done, and that the present weaknesses in the volume will gradually be overcome as material is assembled for subsequent editions.

For each of the major railway systems of the world, the volume gives a considerable amount of general technical detail, including the gauge, route length operated, track length, number of locomotives and cars by type, floating equipment, description of the "permanent way" including type and weight of rails used, ties, ballast, and gradients. For most systems, a brief description is given of the area served, and the preponderant traffic. Average length of haul is given for freight and for passengers. A map is included for each of the larger systems. For some, especially those serving mountainous areas, a generalized gradient profile is included. Additional details given for many of the railways include brief technical descriptions of train control and signalling equipment and methods, of "notable features," mainly large bridges and tunnels, and details concerning selected named trains, including their routes, distances, scheduled time, average load, average speed, type of motive power, and frequency of service. Slightly over half of the volume is devoted to railways

of Europe. For American railways, each system is described separately, for other countries, the separate companies are described individually, but since most foreign systems are government enterprises and nationally integrated, the descriptions and details apply to the systems as a whole. Thus there is considerably more detail given for the individual component railways in the U. S.–Canadian network than for individual components of the networks in foreign nations. Unfortunately, except for railways having simple patterns with one or very few principle lines, much of the descriptive detail concerning route, gradients, and traffic is too generalized, over too extensive and too inclusive areas, to be of maximum value to the transportation geographer. In this respect, for American railway systems the volume contributes little information that is not equally accessible in statistical reports of the Interstate Commerce Commission, The Official Railway Guide, Moody's *Railroads* or other standard works which give considerably more detail. However, much valuable information is given for foreign lines which can furnish the raw material for many comparative studies. The book would have been considerably enhanced, however, had it included tabulations of total mileage, route mileage, traffic volume and other pertinent detail by countries and subdivisions thereof as it does for individual railway systems.

Since this is a first edition, and contains principally information supplied principally by the railways themselves and by the major equipment manufacturers, it is to be expected that the degree of detail would vary greatly from country to country and from system to system; perhaps future editions will enable some of the gaps and deficiencies to be rectified. Nevertheless, the present volume contains an amazing amount of detail.

The maps leave much to be desired. Most of them are reproductions of the standard system maps such as are included in timetable folders, reproduced in reduced form with no modification. Many of them contain the areal distortions which are typical of such maps. In some instances the maps of foreign systems were apparently drawn especially for the volume, but are very crude, and lacking in detail. Relatively few have scales. In many instances, as for example on the map of Cuba, important localities mentioned in the text are not shown on the maps.

The descriptive material on the railway systems themselves, as distinguished from the descriptions of the equipment, is very useful to the geographer, but its usefulness could be much improved by a somewhat better breakdown of the information on component parts of the larger systems, particularly those systems in which there is much difference among its parts, as regards track, roadbed, equipment, gradients, and other features. It is of little value, for example, to group such detail for the entire rail system of Russia.

As may be expected in the first edition of such an ambitious work, there are numerous errors both of commission and of omission. For example, only a few of the maps differentiate electrified lines. The map and the statistical and descriptive material of some systems is not inclusive of the entire system as, for example, the Gulf Mobile & Ohio the representation of which completely omits the portion of the system which was formerly the Alton Road, and which now constitutes about one-half of the total system. Some maps show double and multiple track; others do not. In many instances the named trains which were selected for description are the major ones of the respective systems; in other cases they are representative ones but not necessarily the most important; no indication is given of which is the case for any given system. In a number of instances, as for example the Illinois Central and the N. C. & St. L., the equipment selected for detailed description is no longer used in large numbers and is representative of neither the most modern nor the most numerous types on the respective systems.

In spite of these shortcomings, most of which may be gradually eliminated by correction or addition in subsequent editions, the volume marks a milestone in railroad literature, and should satisfactorily serve as a standard reference work on the physical characteristics of the leading railway systems of the world. Thus it fills a gap that has long been felt. It should be very useful to the increasing number of geographers who are specializing in transportation geography, some of whom, presumably, will use information in this volume as a basis for comparative studies of the railway systems of different regions, countries, and continents, and thus begin to develop a branch of geography that has been largely neglected.

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Climate in Everyday Life, by C. E. P. BROOKS. 314 pp.; maps, diagrs., tables, references, index. Philosophical Library, Inc., New York, and J. and J. Gray, Edinburgh, 1951. $4.75. 8½ x 5¼ inches.

Here is a book that will be of interest to people in many walks of life—industrial engineers, house and city planners, the economic geographer, and the average citizen. The author, C. E. P. Brooks, is well suited to prepare a treatise on the implications of climate to the economic and other affairs of everyday life. He has spent a lifetime in the study of climatology and is an authority on various aspects of it, as evidenced by his many papers and books. His previous books include *The Evolution of*

Climate, Climate, British Floods and Droughts, The Weather, and *Climate Through the Ages*. Formerly Chief of the British Meteorological Office, he is now retired. His scientific activity, however, is in no way diminished. Only recently he prepared a very penetrating analysis of a technical paper emanating from the reviewer's office on climatic limits for materials design and testing. He is serving as consultant to the American Meteorological Society on its special project, *Meteorological Abstracts and Bibliography*.

The present book actually resulted from a paper, "*Climate and the Deterioration of Materials*," which Dr. Brooks prepared for the Royal Meteorological Society in 1946. It contains 314 pages, 34 figures, 26 tables, 3 appendices (climatic tables), and an excellent selected bibliography of 155 references in various languages. There are three principal parts: Part I (7 chapters), *Living with Man*, is an account of climate from the point of view of the man living in it. Part II (3 chapters), *Climate As An Enemy*, treats of climate as a deleterious set of forces with which man in his economic pursuits must contend. Part III (2 chapters), *The Controls of Climate*, deals with heating and air conditioning, lighting, clothing, and protection from the more violent phenomena of climate.

The role of weather and climate in human activities has long been debated and doubtless will continue to be the subject of speculation and study for ages to come. In recent decades, however, mere speculation on this subject and its many facets has been progressively replaced by accurate systematic observations by laboratory experimentation, and by valid statistical treatment of data. Whereas an Ellsworth Huntington had a limited body of facts from which to generalize, present-day bioclimatologists have improved techniques and working material. One of the attributes of this book is the discussion of the effects of climatic elements on the conditions of everyday life in understandable English, with mathematical formulae generally kept to a minimum. On the other hand the author in the enthusiasm for his subject has a tendency to overemphasize the effects of climate on man and his activities. In this he tends to revert to the thinking of earlier decades in the present century and ignore later experimental data. Sunstroke (or heatstroke) is no longer considered fatal nor the deterrent to white man's existence in the Tropics as it once was. Even the British Army has officially discarded the use of the "time honored" topee in those latitudes. Recent advances in human and animal physiology, in Arctic and Tropical housing, and in practical engineering indicate that white races and colored races alike may live, thrive, and produce domestic animals and crops in much higher and lower latitudes than believed to be true a few short years ago. Climate, we know today, is significant (and very much so) to human life and activity; but it is rather to be considered as a limiting factor, often to be slowly and steadily conquered, than as an absolute determinant. Panama, hostile to white man's occupancy at the turn of the century, is now eminently suitable as a habitat for white men (as well as for white women). Further, not all would agree with the author in his declaration that "the climate of Britain and especially of southeast England is on the whole ideal for most forms of human activity."

As a reference book, this volume has much excellent material presented in readable form. If read and used in a critical manner it has much to commend it.

HOYT LEMONS

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